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SIGNIFICANCE OF THE HUMAN BEING AS AN ELEMENT IN AN INFORMATION SYSTEM: WWII FORWARD AIR CONTROLLERS AND CLOSE AIR SUPPORT

by

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March 2002

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13. ABSTRACT

This research will explore the relevance of the human being as an element in an information system. The purpose of this study is to analyze the influence technology, especially information technology, has had on the way human beings understand and use information systems. This study will look at the use of forward air controllers and close air support in the European Theater of Operations during WWII and evaluate the technology, the doctrine and the people involved as they related to the forward air control-close air support information system. Other areas that will be discussed as they relate to the development of close air support include: incremental vs. radical change, organizational culture and change, and the dynamic nature of current and future operations as they relate to information systems.

The primary research objective is to explore the answer to the following question: Based on the role of forward air controller in the European Theater of Operations during World War Two, what is the significance of the human being as an element in an information system? Secondary questions include: What are the necessary elements that make up an information system? How and where were forward air controllers used and were they effective? What were the information systems used by the forward air controllers and were they effective? Last, what implications do the findings of this research have for current technologies, organizational structure and the interaction between human beings and information systems in U.S. military operations?

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SIGNIFICANCE OF THE HUMAN BEING AS AN ELEMENT IN AN INFORMATION SYSTEM: WWII FORWARD AIR CONTROLLERS AND CLOSE AIR SUPPORT

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Submitted in partial fulfillment of the
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I. INTRODUCTION

What is an information system? Mason and Mitroff (1973) and Cohen (1983) conceptualized information systems (IS) in terms that are useful in a discussion about forward air controllers (FACs) and close air support (CAS) as parts of a military information system. Replacing their use of "business client" with the term "warfighter" yields a workable definition: "Information systems provide warfighters with information [data] in a form, format, and schedule that maximizes their effectiveness." Information systems help the human being to select, organize and structure data so that it is useful for more efficient management and decision-making. In a purely military context, information systems involve sensing capabilities, command and control (C^2), management, and the information content of weapons (Arquilla 2001).

As technological innovations continue to be injected into the U.S. Armed Forces, the reliance on and faith in technology as a panacea to correct present and future force deficiencies increases. The dramatic increase in information availability fosters, in some decision-makers, a conviction that the human being is no longer a necessary element in the Information Age (Boland 365). Believers in this paradigm are known as technologists, or what Mackubin Thomas Owens would call, technophiles (Owens, 1998, p 67). Though not the dominant paradigm, techno-centric thinking is increasing as military decision-makers confuse data with knowledge and understanding. Thomas Davenport, a consultant and reengineering advocate wrote, "Our fascination with technology has made us forget the key purpose of information [systems]: to inform people" (Haigh, 2001, p 25).

In the past, military leaders have often sought innovations that would allow them to strike farther, with deadlier force, while reducing risk to their own personnel. The airplane was one such innovation that seemingly allowed military leaders to achieve their goal. But, the airplane could do more than long-range bombing. It could also be a powerful asset to ground forces in close proximity to the enemy. This concept was seriously considered and developed by the American Army Ground Forces (AGF) and Army Air Forces (AAF) in the European Theater of Operations (ETO) in World War

Two (WWII). Remarkably, innovations in CAS and the use of FACs were achieved despite resistance from AAF commanders in Washington D.C. The FACs and their signaling and communication methods, combined with the CAS aircraft, made up an information system that had remarkable effects on the enemy.

Today, military leaders continue to seek new ways of improving the effectiveness of their forces. Like past leaders, military leaders of today tend to seek out technical advances over organizational reform, doctrinal review and personnel training. The cult of the technologist appears to be alive and well in today's armed forces. The rate at which new systems are added and removed from military systems is a testament to this trend. Keeping abreast of the latest advances in technology is essential to military success but up to date organizational structures, doctrine and personnel training is just as important.

A. PURPOSE

This research will explore the relevance of the human being as an element in an information system. The purpose of this study is to analyze the influence technology, especially information technology, has had on the way human beings understand and use information systems. This study will look at the use of FACs and CAS in the ETO of WWII and evaluate the technology, the doctrine and the people involved as they related to the FAC-CAS information system. Other areas that will be discussed as they relate to the development of CAS include: incremental vs. radical change, organizational culture and change, and the dynamic nature of current and future operations as they relate to information systems.

The primary research objective is to explore the answer to the following question: Based on the role of forward air controllers in the European Theater of Operations during World War Two, what is the significance of the human being as an element in an information system? Secondary questions include: What are the necessary elements that make up an information system? How and where were FACs used and were they effective? What were the information systems used by the FACs and were they effective? Last, what implications do the findings of this research have for current technologies, organizational structure and the interaction between human beings and information systems in U.S. military operations?

B. BACKGROUND

In today's technology-centered military, many commanders share a desire to have what Admiral Bill Owens champions as the "system of systems." The system of systems, a high-tech and near-automated capability, will allow commanders to achieve "dominant battlespace knowledge, near-perfect mission assignment, and immediate/complete battle assessment" (Owens, 2000, p 98-99). Figure 1 depicts these three capabilities within the system of systems framework. The three rings represent the traditional functions of command: to see, to tell and to act. It should be apparent that the system of systems depicted in Figure 1 is similar to the "observe, orient, decide and act (OODA) loop." However, Owens neglects to point out the intersection (shaded area) of the see, tell and act rings. This is arguably the most important part of the OODA loop and system of systems; it is the decision element – the human element of the system. See figure one below:

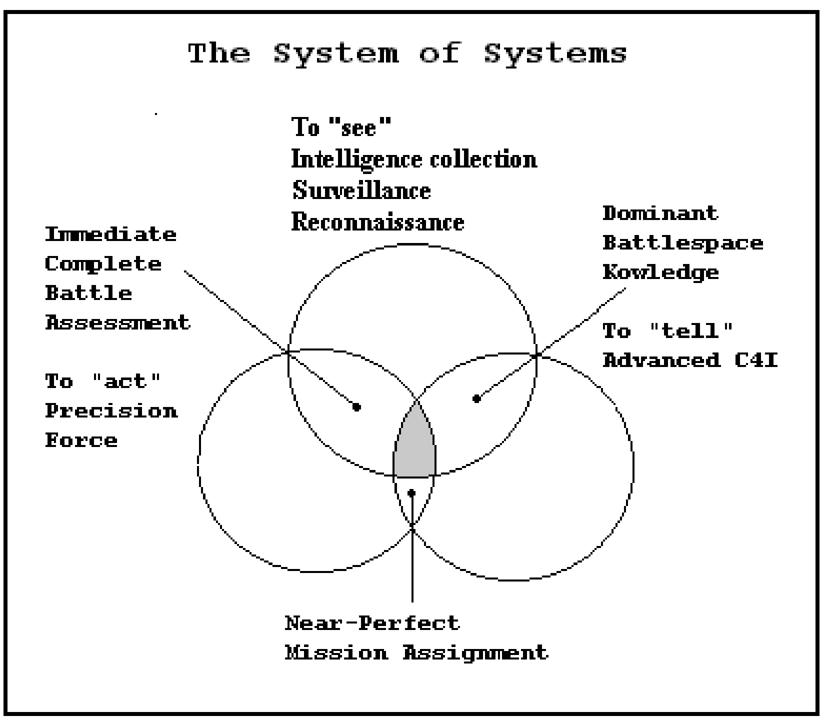

Figure 1. The System of Systems. (After: Owens, 2000, p. 99).

It is as if the proponents of the system of systems believe that technology alone holds the keys to quick and relatively inexpensive victories. Casualty aversion, real or perceived, limited personnel and tightly controlled funding resources are some of the factors that contribute to this utopian belief. Moore's Law, the theory that computer chip processing speed and memory capacity in bytes per chip will increase by a factor of ten every five years and by a factor of 100 every decade (Denning, 1999, p 294), has been unjustifiably extended to all areas of information systems and technology (Arquilla 2001).

Granted, technological improvements have bolstered U.S. military capabilities, especially in the information systems that they employ. However, can these new and future systems be effective without human interaction? Admiral Owens states that, "one of the greatest opportunities of the current Revolution in Military Affairs is to design and build computer networks that can enhance-and replace-humans in many aspects of the data "fusion" process (Owens, 2000, p 135)." The data "fusion" process and its meaning will be addressed later in this study.

Advanced sensors, targeting devices and precision-guided munitions (PGMs) have improved the accuracy and lethality (the information content of weaponry) of today's forces at even greater range. Advances in command, control, communications, computers, and intelligence (C^4I) have increased military capability and flexibility. Despite these high-tech improvements the U.S. military faces significant challenges in locating the enemy and avoiding friendly-fire casualties (Arquilla 2001; Dept. SECDEF Wolfowitz 22 February 2002). An example of this occurred in the ongoing operations in Afghanistan where a stray PGM from an American bomber wounded five U.S. servicemen and killed three others (Wood, 2001, p 1). In another accident in March of 2001, a misguided bomb at a training site in Kuwait killed six servicemen. The bomb that killed these servicemen was also a PGM (Wood, 2001, p 1). Friendly fire does not go away; though it is far less a problem than WWII, Korea, or Vietnam (Arquilla 2001).

Even though improvements in technology greatly improve military capabilities, the question that arises is whether technology can completely replace human judgment and intuition, especially when lives are at risk? Is it possible that the U.S. military's near-total faith in technology is partly responsible for training shortfalls, associated with the human being-technology interaction, that caused the previously mentioned accidents? Is it possible that some of the lessons learned from WWII have been forgotten?

Sixty years ago AAF and AGF officers sought the answer to the previous questions. Although the context of the questions was different and the level of technology was a mere shadow of what exists today, the importance was just as legitimate and, arguably until the events of September the 11th, a great deal more urgent. The WWII invasion and breakout of Normandy marked a crucial turning point in the allied effort to defeat the Germans in the ETO. AAF and AGF officers struggled with the problem of bringing the airplane and its firepower to the front lines in a CAS role. Due to organizational and cultural differences within the U.S. Army at that time, no effective CAS doctrine existed. Many attempts were made to improve CAS but most failed. It was not until the introduction of the FAC, combined with the technology of the day, did the CAS mission succeed.

C. SCOPE AND METHODOLOGY

The scope of this study will focus on an analysis of available historical documents relating to the use of FACs and CAS by U.S. Forces during the European Campaign of WWII. An attempt will be made to evaluate the effectiveness of the FACs and their underlying information system(s). The first use of CAS occurred during WWI, but only briefly. I chose WWII as a case study because it was the first major conflict where CAS and FAC doctrine was developed and effectively employed. I chose to focus on the American effort to develop CAS because it was done, for the most part, under the stress of wartime conditions. Little attention was given to CAS development in the interwar period because of the AAF's single-mindedness about pursuing long-range strategic bombing technology and doctrine. Yet, by war's end, dramatic results were achieved. A brief discussion of German CAS development will be included and contrasted with the American effort.

Included in this study will be a brief discussion of information theory and what constitutes an information system and its relationship to human beings. This study will also utilize first hand accounts from American fighter-bomber pilots. A discussion of interviews held with U.S. Air Force (USAF) F-117 pilots and U.S. Marine Corps (USMC) Force Reconnaissance personnel conducted during Red Flag Exercise 01-02 at Nellis Air Force Base (AFB) will also be included. The overall goal of this study will be to apply the analysis of the WWII case study and the discussion on information systems to current U.S. operations and technological trends.

D. RESEARCH METHODOLOGY

The research techniques used for this thesis comprise the following steps:

1. Review the historical records of U.S. Forces in the ETO during WWII.

2. Determine the utility of the FAC during WWII.

3. Determine the information system(s) utilized by the FAC and its utility.

4. Conduct a literature review of information systems and their elements and discuss their relationship to human beings.

5. Explore/observe current implementations of FACs and discuss the findings.

6. Conduct interviews with current aviators and ground personnel who conduct the CAS and FAC mission.

7. Conduct interviews with WWII fighter-bomber pilots who performed CAS and FAC duties.

8. Based on the historical case study and current technology and concepts of operations, determine the relevance of the human being as an element in an information system.

E. ORGANIZATION OF STUDY

The thesis is organized as follows:

1. Chapter I: Introduction

This chapter provides the purpose, background, scope and research methodology of the thesis.

2. Chapter II: Information Systems and Technological change

This chapter provides a discussion of information systems and their elements. It will include a look at the dynamic nature of information as it relates to individual human beings and their role in information systems. A discussion of technological change and its relationship to information systems and organizational structure will finalize the chapter.

3. Chapter III: The Interwar Period

This chapter will look at the interwar period before CAS doctrine was formalized. It will also explore the events that occurred that prompted AAF and AGF officers to develop CAS tactics. Included will be a brief discussion of German combined operations doctrine.

4. Chapter IV: Close Air Support and The Forward Air Controller

This chapter will examine and evaluate the introduction and evolution of CAS and the FAC in the ETO and the associated information systems. First hand accounts from WWII fighter-bomber pilots will be included to add more insights to the study. An analysis of the overall effectiveness of the FAC will be provided.

5. Chapter V: Current Operations

This chapter will discuss current operations and exercises and determine if any similarities exist between the case study and modern concepts of operations. A brief discussion of current technologies and trends will be included.

6. Chapter VI: Conclusions and Recommendations

This chapter will provide conclusions and recommendations concerning the relevance of human beings as elements in information systems.

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II. INFORMATION SYSTEMS AND TECHNOLOGICAL CHANGE

A. INTRODUCTION

Sun Tzu on The Art of War:

> "1. Generally, management of many is the same as management of few. It is a matter of organization."
>
> "2. And to control many is the same as to control few. This is a matter of formations and signals" (Sun Tzu, 1971, p 90).

The WWII case study (to be discussed in a later chapter) of FACs and CAS deals with a military information system that resulted from technological as well as organizational and doctrinal changes. In order to understand information systems in terms of military organization, doctrine and practice, a few questions must be answered. First, does military doctrine drive technological development and dictate information system architecture and implementation? Does form truly follow function? Or, does the opposite scenario more closely resemble reality; do technological changes spawn new doctrine and organizational structures? Can or should both processes occur simultaneously? Embedded in these questions are the concepts behind information systems theory. According to McGrath and Hollingshead (1994), information systems promise three things:

1. Improved task performance.
2. Overcoming time and space constraints on collaborative efforts.
3. Increasing the range and speed of access to information (McGrath and Hollingshead, 1994, p 13).

The preceding promises appeal to military commanders as they seek more efficient methods of conducting operations. Some seem to take it on faith that these promises are guaranteed. Improvements in information systems and technologies in the military have many implications. Automation may replace many of the tasks that commanders perform. However, poorly designed information systems enhanced by technology may overload commanders with vast quantities of information delivered at unprecedented and unwieldy rates. This problem faced commanders in the Gulf War (Arquilla 2001). In a discussion about commanders applying judgment, common sense and the laws of probabilities in military actions involving large amounts of information, Clausewitz warned that, “these are difficult enough to apply when plans are drafted in an office, far from the sphere of action; the task becomes infinitely harder in the thick of fighting itself, with reports streaming in” (Clausewitz, 1989, p 117).

Following Clausewitz’s discussion about information overload, it will be important for military decision-makers and information systems designers to remember that there are limitations to human cognition. As information systems are implemented in the military to reduce uncertainty and enhance the decision-making process, designers must keep in mind that, sometimes, less can be more. The following graphs (figures 2 and 3) may illustrate this point more clearly:

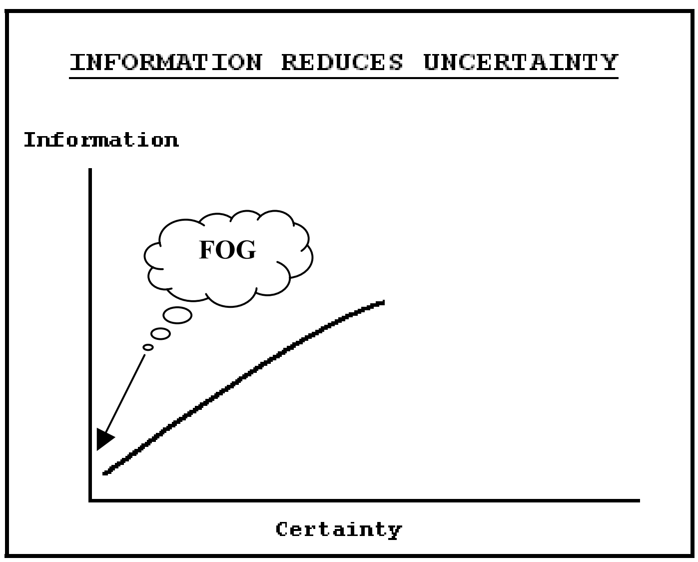

Figure 2. Information Reduces Uncertainty. As the amount of information increases, the amount of certainty increases. Clausewitz’s “fog” is reduced. However, there is a point where information and certainty decouple and the relationship ceases.

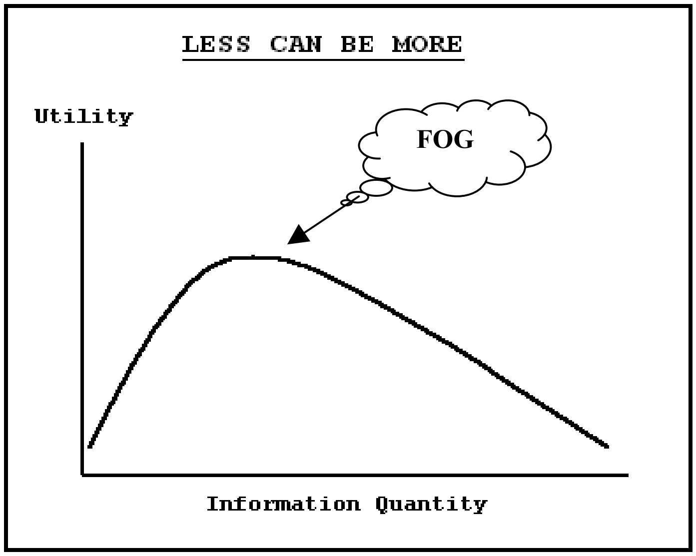

Figure 3. Less Can Be More. As the amount of information increases, its utility increases to a point where increased information may induce the "fog" that Clausewitz mentions, thus reducing the information's utility.

A more ubiquitous information system may also allow commanders tighter control over subordinate leaders, adversely affecting their motivation and effectiveness. U.S. Navy Captain James FitzSimonds points out that there is no reason to expect that commanders will be able or willing to avoid involving themselves in actions taken by their subordinates, of whose circumstances they will believe they have full knowledge (FitzSimonds, 2000, p 5). While new technology and information systems can benefit commanders, the doctrine and organizations that these systems support must be evaluated and changed if necessary. Decentralized command principles may be just one of many possible things to change.

There is another very important effect of changes in technology and information systems design. That effect is on the human element of information systems. Questions about the human element in information systems are not new in the military, but little research has been conducted to discover what equates to that element. Will improved information systems, similar to those that Johnson and Libicki (1995) describe in *Dominant Battlespace Knowledge: The Winning Edge*, result in more cohesive military operations? Or, will information saturation confuse military cohesion? One thing is certain; all military units are a combination of psychological, cultural, social and political subsystems. All of these subsystems form the human element. Organizational concerns are indeed one aspect of the human element but is there more that commanders and designers of information systems should consider? Is the human being an essential part of an information system? Before addressing the previous questions, the components that make up information systems will be discussed.

B. ELEMENTS OF INFORMATION SYSTEMS

> "The primary purpose of any theory is to clarify concepts and ideas that have become, as it were, confused and entangled" (Clausewitz, 1989, p 132).

As depicted in Figures 2 and 3, information systems, in the military context of this study, are designed to reduce the level of uncertainty for the decision-maker (warfighter). Information systems can streamline communications and allow for more efficient use of resources. If recent trends persist, reliance upon information systems will increase in order to reduce the number of personnel necessary to man a ship or submarine, fly a plane, or execute and complete a mission (Wolfowitz 22 February 2002).

When describing information systems, it is illustrative to depict information in a certain hierarchy. Borrowing from Cleveland (1985), Lucky (1989), and Ackoff (1989), information fits into the following hierarchy:

1. Data
2. Information
3. Knowledge
4. Understanding
5. Wisdom

Information systems create the opportunity to make the link between data and information. In the book, *In Athena's Camp: Preparing for Conflict in the Information Age,* Arquilla and Ronfeldt (1997) illustrate how each element in the hierarchy builds the foundation for the next. Figure 2 depicts this information pyramid:

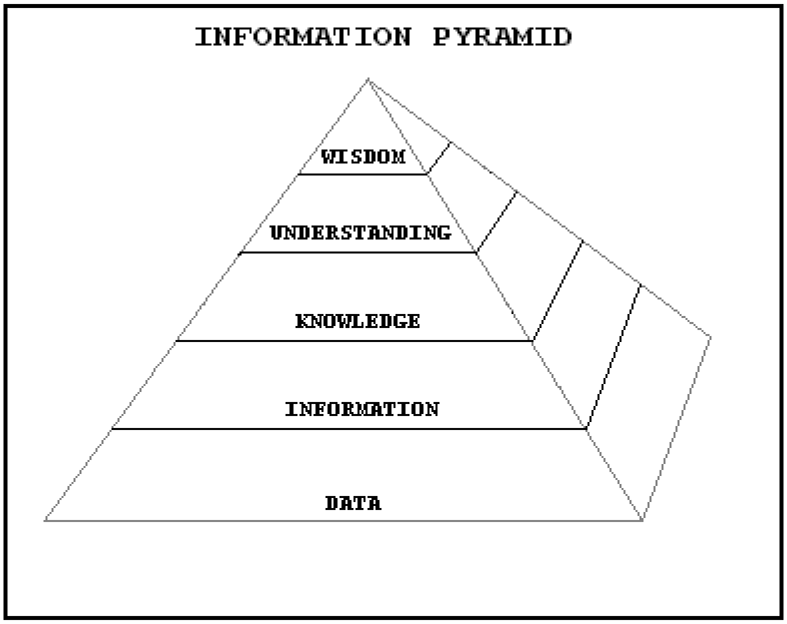

Figure 4. Information Pyramid. (After: Arquilla and Ronfeldt, 1997, p 146).

The information pyramid is a simple, yet highly instructive, way to illustrate the concept of the information hierarchy. It is important that the distinction between data and information remains intact. Data is simply a sign that represents an object, a count, or a description that can be interpreted to produce information (Ackoff, 1989, pp 3-9). The interpretation of data is the key. The sorting, discriminating and collating of data into meaningful information will remain a human cognitive process. This statement will always be true until computers gain a measurable level of consciousness; that discussion is better left to science fiction. Human beings provide meaning to data. When knowledge has been synthesized and applied to a situation, the decision-maker has achieved understanding. The wisdom that follows from understanding is what is known as situational awareness; Napoleon called it *coup d'oeil* (Mackubin, 1998, p 69).

Boland states that,

> the essence of information is revealed to us in its name. Information is an inward-forming [or in-formation]. It is the change in a person from an encounter with data. It is a change in the knowledge, beliefs, values or behavior of that person (Boland, 1987, p 363).

He describes the process of creating information from data as "sense-making." Owens would attribute sense-making to "data fusion". The cognitive process of sense-making is closely related to the information hierarchy. The hierarchy of sense-making proceeds from awareness to understanding, followed by wisdom (Arquilla 2001; Cooper 1994 and Rothrock, 1994, pp 71-76).

The confusion over differentiating between data and information is not new. Many of the decision-makers in today's military do not understand the relationship between data and information. They do not grasp the concept that information is synthesized in the mind by data that is structured, in line and in order. Their misunderstanding is carried farther to the concept of knowledge. It is common to hear the words information and knowledge used synonymously in discussions about information systems. The "Wall of Knowledge" is the catchphrase that military decision-makers use to describe a system of systems that will provide them with dominant knowledge or omniscience.

The problem with the last assumption is that it relies on technology to provide decision-makers with knowledge, thus allowing them to bypass the sense-making process. As Boland states,

> the images and metaphors we use to think about information without inward-forming distorts our very ability to think about the larger world of human affairs. This is because we have allowed an image of information without in-formation to become the central, defining image of the world (Boland, 1987, p 364).

The confusion over the terms data, information and knowledge may lead to the design and implementation of information systems that do not take into account human beings as operators and users of the system. It may lead to systems that do not inform people.

Although not the dominant view, Boland's article, "The In-Formation of Information Systems," points out five fantasies that people develop about information. The first is that "information is structured data". Boland argues that this fantasy allows people to ignore the "hermeneutic problem of interpretation" (sense-making) and that it serves to objectify information. Information departs the abstract and becomes a commodity or physical entity (Arquilla and Ronfeldt, 1997, p 148). The second fantasy implies that "organization is information". Here, the individual in an organization is considered moot. The organization is information belief assumes that the automated manipulation of structured data can substitute human beings throughout any organizational hierarchy. It also assumes that information has a ubiquitous presence in all things (Arquilla and Ronfeldt, 1997, p 147; Berkeley, 1949, pp 10-17). In 1953 a *Fortune* magazine article linked this scientific approach to information, pioneered by communications engineer Claude Shannon, to the conceptualization of DNA (Bello, 1953, pp 136-410).

Boland's third fantasy is that "information is power". This fantasy, as is true with all the others, argues that the information system designer can manipulate both power and information while excluding the human being from the process. Therefore, the information system ought to determine what is information and wield power based on that determination (usually a human relational phenomenon). The fourth fantasy, that "information is intelligence", takes the unmistakable position that human beings and their sense-making abilities are no longer relevant in information systems. This fantasy takes on the flavor of Owens' system of systems view.

The fifth and final fantasy is that "information is perfectable". Here, the faith of decision-makers is won. If information can be perfectable, then there can be no mistakes. It is from this perceived perfectability of information that the reliance on technology and information systems as a panacea to correct present and future shortcomings grows. However, this fantasy falls apart when it comes into contact with the real, unpredictable world. Clausewitz calls this friction (Clausewitz, 1989, pp 119-120). All five fantasies rely on the premise that human beings, with their differences and problems, are not a part of the information system. That premise is "doomed to failure, because information is not a thing, it is a skilled human accomplishment" (Giddens, 1979, p 373).

> Unfortunately, by fantasizing that information is structured data, we deny the importance of dialogue as the basis for all human understanding. By taking structured data seriously as a substitute for information we deny the universal hermeneutic problem that we all continuously confront: the problem of engaging in dialogue in order to gain understanding and make sense of the world (Boland, 1987, p 371).

Boland's views are not predominant, merely expressive of one side of the debate. John Arquilla and David Ronfeldt (1997) offer three different views of information in their book, *In Athena's Camp: Preparing for Conflict in the Information Age*. The first two views of information that they present are fairly straightforward and readily understandable. The first view defines information in terms of the message it conveys. It follows the information hierarchy in that its base is raw data that can be arranged to form meaning. This meaning is placed in context to build upon the knowledge and understanding of human beings. The result is the information pyramid that is depicted in figure 4. The entire pyramid is called information (Arquilla and Ronfeldt, 1997, p 146). I would argue that by labeling the pyramid "Information," many military leaders confuse the terms data, information, knowledge and wisdom as meaning the same things.

The second view characterizes information as a medium. It takes the engineer's approach in that it is concerned with the creation, storage, transmission and reception of the information (or signal). This view of information is less about content and more about signal theory. The medium school of thought focuses on encryption, propagation, integrity and reliability of the signal. This view of information is very interesting as more and more of our new and current systems rely upon connectivity. The field of signals analysis and manipulation will continue to make this view of information relavent (Arquilla and Ronfeldt, 1997, pp 147-148).

The third view of information is a more challenging concept, almost metaphysical. This view categorizes information as a physical property that all things contain. It adds information to the list of essential components (i.e. matter and energy) that are resident in all things. This view is especially relavent for the military. When viewed from this standpoint, the information content of a round moving down range can be either highly destructive or highly instructive to the enemy. In another context, the information content of potential targets that can be sensed from the new, highly-sensitive, space-based systems exemplifies this view (Arquilla and Ronfeldt, 1997, pp 148-149).

Still another view of information comes from William H. McNeill (1982) in his book, *The Pursuit of Power*. In his book, McNeill examines 1,000 years of societies and their militaries. He points to the technological development of weapons in WWII as a watershed moment in history. This improvement in weapons systems increased the information that is "embedded" in weapons. McNeill wrote, "The results of systematic application of scientific knowledge to weapons design rivaled transnational organization in importance at the time." He went on to say, "scientists, technologists, design engineers, and efficiency experts were summoned to the task of improving existing weapons and inventing new ones on a scale far greater than ever before" (McNeill, 1982, p 357).

McNeill believes the concept of "complete weapons systems" emerged during this time. A complete weapons system meant that everything had to be standardized, from ammunition to same speed tanks, infantry carriers and self-propelled artillery. Everything had to flow, from production to operation. Essentially, increasing the embedded information in weapons allowed for standardization. McNeill pointed out that radar was one such system that represented a major innovation of weapons systems. He added to the list: jet airplanes, proximity fuses, guided missiles and ultimately, the atomic bomb (McNeill, 1982, p 359).

C. TECHNOLOGY AND ORGANIZATIONAL CHANGE

Technological innovations and their resulting implementation have improved military capabilities and lethality to a great extent. Military information systems benefit from technological advances. These technological advances result in changes in hardware that produce higher-paced operations and increased demands upon "speed of command" (Cebrowski, 1998, p 32). At the rate that new information systems are installed and removed and reinstalled on today's military platforms, the challenge that faces us is not technological, but organizational. The test will be how best to reorganize people around these new information systems in order to reap their full potentialities.

> Information technology plays a crucial role in business reengineering, but that is easily miscast. Modern, state of the art information technology is part of any reengineering effort, an essential enabler since it permits companies to reengineer business processes. But, merely throwing computers at an existing business problem does not cause it to be reengineered. In fact the misuse of technology can block reengineering altogether by reinforcing old ways of thinking and old behavior patterns (Hammer and Champy, 1993, p 83).

As mentioned previously in this chapter, military organizations are microcosm of society with their own specific cultural identities. They each have their own customs, hierarchies, politics and psychological views. Elting Morison, writing about innovation in the U.S. Navy, noted that the adoption of new technologies poses a threat (and may even eliminate) existing "mores and structures" within the Navy (Morison, 1966, pp 17-44). Cultural resistance to change is alive and well in the Navy, but it is a reality in all organizations.

It is clear from existing business and management science literature that for the introduction of new technologies to be successful, changes in personnel requirements will occur along with the centralization or decentralization of organizational structures. According to Dodge, Webb and Christ (1999), the effects from these changes may take seven or more years to be fully realized (Dodge, 1999, p 11). This delay, from a technology's first introduction to its routine operational use, has been a common trend when previous military innovations were first introduced to a military (Arquilla 2001). I would argue that this is due, in part, to cultural and organization resistance to change and the lag that occurs when new doctrine is developed to meet the technology. This is possibly not the best way to go about transformation.

Coordination theory is another way to look at the introduction of new technology, information systems and organizational change. This is an interactionist view that contends that both organizational requirements and information technology come together to create organizational change (Crowston and Malone, 1994, p 7). This view is very similar to Harold Leavitt's Diamond as seen below in figure 5:

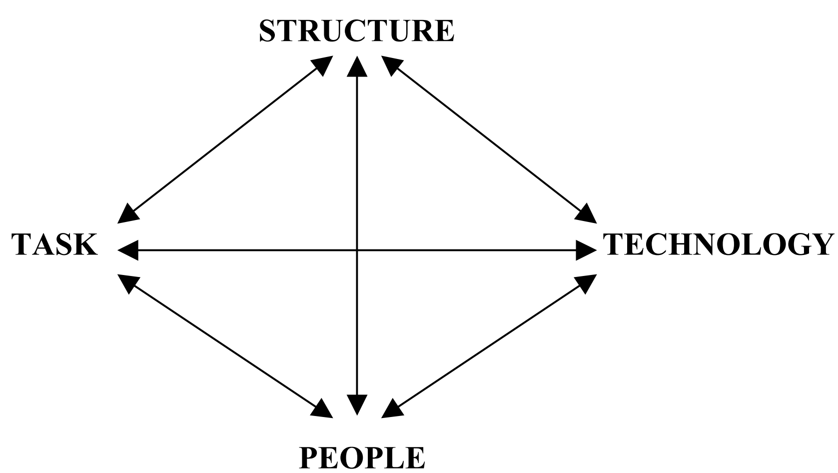

Figure 5. Leavitt's Diamond. (From: Leavitt, 1965).

Leavitt's diamond illustrates how no part of an information system is isolated from individual or organizational behaviors. Basically, every element of organizational life affects every other. If you change the technology or information system, you will change the organizational structure, the people and the task, etc. (Wilson 7).

D. CONCLUSION

This chapter attempted to explain some of the popular concepts relating to information and information systems. Another purpose of this chapter was to link these concepts of information systems to current military thinking about the efficacy of information in light of the RMA. Hopefully, enough of a distinction was made between data and information so that the concept of information, followed by the concepts of knowledge, understanding and wisdom, are understood to be in the human realm vice the technology realm. Technology is a great enabler, allowing military decision-makers to be more efficient and better informed. Technology has also had a significant influence on military organization and doctrine. What is important to understand is that technology can improve our ability to know, understand and gain wisdom, but it is doubtful that it will ever replace these human capabilities.

In the following chapters, the previous concepts will be discussed as they relate to the development of CAS and the use of the FAC prior to and during WWII. The CAS-FAC information system will be examined and, finally, critiqued based on its effectiveness. The results of this examination will be applied to the current RMA and its regard for information systems. Important points that will, hopefully, be uncovered include the observation that innovation occurred after a logical analysis of strategic requirements or for other reasons; that technological advances shaped military capabilities (technology drove doctrine) or not; that political and cultural considerations within the military organization shaped the course of innovation or not.

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III. THE INTERWAR PERIOD

A. INTRODUCTION

The interwar years (1919-1939) were an interesting time in military aviation. The pace of technological advances in aircraft design and communications quickened after World War One. At the close of the war, the U.S. Army Air Corps viewed CAS (then called general air support of ground forces) as a primary mission (Mortenson, 1987, p 6). Although the U.S. entered WWI late, its air forces began to hammer out and apply CAS principles with positive results, specifically, in the St. Mihiel Offensive in September 1918 (Fogleman, 1971, 81). In this battle, thousands of American and French planes were used to strafe German positions and retreating troops and equipment.

The U.S. was not alone in its development of CAS. Germany also conducted air support of ground forces in the final months of WWI. They places liaison officers in the trenches and even attempted using radios to direct its aircraft against the enemy (Hallion, 1989, p 14). Analyzing the paths that the two nations took, in terms of defining and developing CAS technology and doctrine, can serve as a valuable lesson for today's military decision-makers.

This chapter will focus, primarily, on the U.S. military during the interwar period. It will show how organization, culture, technology and attitudes about innovation affected its readiness to conduct CAS upon entering WWII. A brief discussion about German development of CAS will be included in contrast to the U.S. effort. Although German innovation during the interwar period is not the focus of this case study, its differences with and influence on U.S. innovation are relevant to the discussion.

B. PATH TO INNOVATION

1. The U.S. Effort

Immediately following WWI, the U.S. appeared to be on a clear path to develop an effective CAS doctrine. American successes in the battles of 1918 inspired Lt. Col. William C. Sherman's "Tentative Manual for the Employment of Air Service" and General William "Billy" Mitchell's "Provisional Manual of Operations of Air Units."

These two manuals were written immediately after the war and attempted to record the experiences of the Air Service (later becoming the Air Corps in 1926). Both Sherman and Mitchell agreed that the use of air power on the front lines could be decisive in battle (Maurer, 1978, p 399).

For a brief period before the end of WWI (and immediately after) there was an intense effort to create and perfect CAS principles and develop aircraft for that mission. Air power was gaining prominence in military affairs. The potential of air power in war was, it seemed, limitless. The efficacy of air power did continue to grow, but it was in the direction of strategic air power, not CAS. In 1921, the Army created the 3rd Attack Group to focus on developing the CAS mission and its doctrine (Kennett, 1990, 43). The 3rd Attack Group was to be a ground attack unit made up of four, former border surveillance squadrons.

Slowly but surely, the 3rd Attack Group withered away under the interwar era budgetary cuts. Two of the original four squadrons were deactivated, while the personnel in the remaining two were severely cut (Muller, 1996, 175). All innovation to the CAS mission ceased due to the lack of funding and neglect of the 3rd Attack Group. The Army Air Forces (AAF) simply ignored the CAS mission.

The belief that air power's potential was limitless was not to last, at least not for CAS. Throughout most of the interwar years, until 1936, there was very limited development of CAS aircraft and even less discussion about doctrine. It was as if the lessons from WWI were forgotten or ignored. There was one area in military aviation that was being emphasized: strategic aerial bombardment. There were many organizational, cultural and political reasons why CAS took a back seat to strategic bombing. Primarily, the U.S.' geographically isolated location motivated the AAF to begin developing plans and doctrine to provide for the defense of the country from a sea-based invasion. Attack from Canada or Mexico seem unlikely. The most conceivable attack would likely originate from a South or Central American country used as a jump-off point. The AAF's use of this scenario as a valid reason to pursue long-range strategic bombing vice CAS was debatable, but it held.

Pursuing the coastal defense mission, the AAF placed more emphasis on the development of aircraft and doctrine to support long-range bombing and bomber protection. In Gen. Mitchell's words, the U.S. entered the "aeronautical era" and many military (AAF) planners believed strategic bombers could win wars almost independently (Mitchell, 1925). Ground forces would not be needed to defeat an enemy. The mentality of "air power exceptionalism", winning a war without using ground forces, reigned supreme in the interwar period (DeSeversky, 1942). Heavy and medium bomber development, as well as the development of fighter aircraft for their protection, was the focus of AAF innovation efforts. In this vein, the Air Corps Tactical School (ACTS) focused its instruction on the use of long-range bombers, independent strike forces and industrial targeting (Mortenson, 1987, p 8).

Thinking about CAS and development of CAS aircraft did not begin again until the possibility of war with Germany and Japan appeared likely. In the early to mid 1920s, the AAF could not look to the international military community for innovative ideas since the 3rd Attack group was the only military unit of its type in the world (Kennett, 1990, p 45). CAS was such a new area of warfare that there was no historical record or corporate knowledge, other than from the last part of WWI, to draw from. To say that the AAF lacked any resources from which to develop CAS doctrine would be incorrect. In a presentation to the Army War College in 1929, Maj. Ross Rowell (USMC) presented a lecture entitled, "Experience with the Air Service in Minor Warfare" (Rowell, 1929).

Maj. Ross Rowell presented the experiences that the Marines had with CAS in their operations in Nicaragua. Ross explained how the Marines used airplanes as artillery and employed them in extremely close proximity of their own forces. They were able to break-up enemy ambushes and fly escort missions for columns. Probably due to their small force size and scarce resources, the Marines had no choice but to maximize the airplane's utility on the battlefield. Despite the useful experiences of the Marines in Nicaragua and their willingness to share them with the AAF, there is little mention of them in ACTS texts from that time (Kennett, 1990, p 45). The lack of interest in the Marines' experiences is reflected in a comment that Gen. Mitchell made in 1930.

> This branch of aviation [CAS] will have most of its application in the future against what are termed partisan or irregular troops, and as are found in Asia, Africa, Mexico and Central America, that is those not equipped with large air forces and which do not move in large numbers but in comparatively small mobile detachments (Mitchell, 1930, p 280).

It is interesting that the AAF chose to innovate almost solely in the area of long-range strategic bombing in light of its positive experiences with CAS in WWI and the USMC's experiences in Nicaragua. The reasons for this choice are varied but include political and cultural differences within the U.S. Army as well as technological influences. These reasons will be discussed later in this chapter. Before these are expounded upon, a short discussion of German innovations in aviation during the interwar period will follow.

2. The German Effort

The Germans also used CAS tactics in the latter part of WWI. They converted their *schutzstaffeln*, protection units used to escort reconnaissance aircraft, into *schlactstaffeln*, or battle units. The *schlactstaffeln* would attack enemy ground units at decisive points during a battle in groups of three to nine airplanes, a *staffel* (Muller, 1996, p 147; Kennett, 1990, p 19). This practice was different from that of the allies, whose planes would fly independently looking for targets of opportunity (this tactic would change, reflecting the German method, later in the war). In 1917, the Germans were using liaison officers in the front-line trenches to coordinate air strikes. They accomplished this by using radios (Hoeppner, 1921, pp 114-118). Arguably, the Germans possessed the best doctrine for CAS during the war. Preparations for the Michael Offensive are evidence of superior German doctrine (Corum, 1992, p 70). The aircraft that the Germans used for this mission were not technologically advanced but their employment of them was revolutionary (Neumann, 1920, pp 80-81).

Although both the German and American innovations in CAS proceeded swiftly in the final stages of WWI, the Germans seemed to learn the lessons of the war better than the Americans. The fact that Germany was placed under tight restrictions, enforced by the Treaty of Versailles, made any innovations in military aviation difficult in the interwar period (during the 1920's, the Germans did conduct some secret experiments in the Soviet Union (Muller, 1996, p 158)). This persisted until Adolph Hitler and the Nazi

Party came to power in 1933. Nonetheless, the Germans conducted quite thorough studies of what went on in the air war during WWI. Perhaps the restraints of Versailles put the German military leadership on a path that forced them to theorize about the applications of air power rather than focusing on technological innovation. As a result of the studies, the German approach to air power sharply contrasted with that of the Americans. The Germans did not place one element (i.e. strategic bombing) over another (i.e. CAS). Murray (1996), states that the Germans recognized the importance of air superiority, the interdependence of air and ground forces on the battlefield, and that the priorities of air power should shift based on the given circumstances.

The Spanish Civil War was another area where that the Germans sought to innovate in the air. The Luftwaffe participated in the civil war by means of an autonomous component called the Condor Legion. The Condor Legion, consisting of relatively few aircraft, did a great deal of CAS doctrine testing under Wolfram von Richthofen. Although the Germans began using CAS in WWI, Wolfram's legion was credited with making great advances in the close support concept (Muller, 1996, pp 161-162). Many nations sent representatives and observers, who wrote a great deal about the events of the war, but the U.S. did not. While Germany benefited from its participation in Spain's civil war, the U.S. missed the opportunity.

Historical records and lessons-learned formed the foundation for German air innovation. The realities of WWI and the Spanish Civil war air operations informed the military decision-makers and theorists in post-war Germany. Unfortunately, this was not true for the Americans. Though the U.S. did enjoy success in WWI, the lessons concerning the use of air power in support of ground forces were nearly forgotten by the late 1930's. The differences between the U.S. and German interwar periods were largely due to political/cultural and organizational relationships. The next few sections will shed light on these topics.

C. CULTURE

It is interesting to consider why CAS did not attract more attention from the AAF. After all, the AAF was a part of the U.S. Army. Why would it not want to develop doctrine that directly supported its service? The American Air Service used applications of CAS principles quite effectively during the final stages of WWI (St. Mihiel Offensive in September 1918) and by the USMC in Nicaragua. Why were the lessons of the previous wars ignored or overlooked? Part of the answer to these questions stems from the culture of the AAF and AGF.

As previously mentioned, the AAF was ultimately interested in strategic bombardment. Its main efforts were in the perfection of long-range bombers and their associated doctrines. Fighter aircraft, whose mission would be to protect the bombers, were also a part of the AAF vision. It is arguable that the AAF latched onto the strategic bombing mission as a way of separating itself from the AGF. The strategic bombing mission would be independent of AGF control. The AAF did not want to be a subordinate element of the AGF. In the years immediately after WWI most of the senior Army leadership were traditional ground officers. By 1930, the AAF avoided any discussion or notion of CAS innovation because of the link it held to ground forces. Culturally and organizationally, the AAF was becoming more separate and distinct due to its role in strategic air power (Mortenson, 1987, pp 8-9).

The complexity of air-ground operations requires that joint exercises be conducted. This, however, did not occur very much during the interwar period. According to Gen. Mitchell's and Col. Sherman's doctrinal writings from WWI, air operations need to be closely coordinated with ground operations to be effective. Again, the AGF and AAF rarely conducted joint operations to work out procedures (Fogleman, 1971, p 152). Commenting on the rarity of CAS exercises, Gen. Earle Partridge said that 3rd Attack Group exercises "were few and far between." He also said that, "Socially, we knew a lot of them [3rd Attack Group officers] we ran into those people at parties and so on, but as for getting together to talk tactics, no." When asked about how the commander of the 3rd Attack Group was getting his doctrine, Gen. Partridge said, "he was manufacturing it (Sturm and Ahmann, 1974)."

Contrary to the AAF point of view, the AGF saw the role of the AAF as one of direct support of the ground forces. The AGF viewed the AAF as a subordinate and supporting branch of the AGF, whose commanders should be able to exercise control over aviation assets. Experience from WWI and analysis of German CAS activities after 1933 convinced AGF commanders that CAS was an extremely important capability. Specifically, the Germans' use of the dive-bomber in Poland and France convinced AGF that it needed a CAS capability (Hallion, 1989, p 132). It was apparent to the AGF commanders that CAS could provide them with substantial increases in firepower on the battlefield.

The argument between the AAF and AGF commanders stifled almost all innovation in CAS. Culturally the AAF and AGF were miles apart. There was however, an open debate on CAS or, more directly, who should control aviation assets. Unfortunately, the debate over doctrine only yielded field manuals (FM 31-35) that merely re-stated each side's position rather than focusing on training and procedures. Training Regulation TR 440-15 was promulgated on 15 October 1935 and attempted to bring the AAF and AGF positions a little closer together to help build a coherent doctrine. Although TR 440-15 did make concessions on both sides of the argument, no resolution was reached. It was not until the publication of FM 100-20 in 1943, which will be discussed later, that any real progress occurred in CAS innovation.

D. TECHNOLOGY

The interwar period saw little change in aviation technology in the realm of CAS. As previously mentioned, the Germans used radios in WWI to direct the pilots to targets of interest. The American Air Service also used radios but with little success. The radios were too cumbersome to operate while flying the airplanes. As WWII approached, communications development was revisited. Tests indicated that airborne reconnaissance was more effective than ground-based direction because of the low reliability of radio transmission. However, the testing of communications prior to the U.S. entering the war was not adequate. An Army War College text of 1937-38 advised:

> Airplane radio sets are most valuable for training. Their combat employment is prejudicial to security and surprise. If not carefully maintained, they are noisy and conversation is difficult. Voice communication is slow and difficult. The best principle for the use of radio is "Silence is Golden." (Carlisle Barracks, 1937-1938, p 44)

Shortly after the war, the Air Service sought a heavily armored airplane that could be used in the CAS role. They wanted an airplane that would maximize firepower on the battlefield. In 1921, Boeing built the GA-1 (Ground Attack) airplane. The Engineering Division of the Air Service designed the airframe and weaponry; the GA-1 was a twin-engine, armored plane with a 37-mm hub-fired cannon. The GA-1 was too heavy from the ¼-inch armor plating and handled poorly (Munson and Swanboro, 1972, p 21). The Air Service's first attempt at technological innovation was a failure. So was the second; the GA-2 was also a failure. However, the Air Service identified it needs and requirements and then sought out the technology that could meet them. This was arguably a reasonable way to go about innovation.

As the interwar years progressed, budgetary cuts deepened. The 3rd Attack Group had to abandon all hopes of fielding an armored CAS platform. Instead, the 3rd had to settle for DH-4 observation planes. These airplanes were previously employed as border surveillance aircraft along the Mexican border; they had engines designed during WWI. An officer attached to the 3rd Attack Group complained, "there is a total of fourteen DH planes in the attack air force of this country" (Fogleman, 1971, p 81). Needless to say, the training and doctrine development was disappointing since the DH-4 could not carry both machine guns and bombs.

As the next several years passed, no improvements in CAS technology were made. Instead, indirect support of ground forces was being pursued. A 1930 ACTS text stated that "the air force does not attack objectives in the battlefield or in the immediate proximity thereof, except in most unusual circumstances (ACTS, 1930, pp 70, 82)." As a result of the debate between attack and indirect support, finding a suitable airplane for the mission was difficult. The DH-4s were replaced by another observation plane, the A-3 (a modified Curtiss 0-1). Later, after continued debate, the Curtiss A-12, followed by the Northrop A-17, were introduced. Neither of these craft were particularly well suited to ground attack. They were lightweight and unarmored. It was not until the development of twin-engine airplanes that any progress was made in CAS technology. The Douglas A-20 was one such plane that could carry one ton of bombs, six guns and travel twelve hundred miles.

The introduction of the A-20 brought some hope to the 3rd Attack Group and for continued development of CAS doctrine. The A-20 had the potential of being a great asset to commanders in the field. The ACTS, after seeing the potential of the A-20, changed its class designator from attack to light bombardment. Doing this appeased those who desired air power to be capable of hitting targets well behind the lines. Unfortunately, the technical innovations in the A-20 did not translate into innovations in supporting ground forces in the CAS role. There was no formal doctrine, not even a field manual, which described the proper employment of the A-20. The ACTS' text, Light Bombardment Aviation, dated 15 January 1940 made this reservation:

> To use this force on the battlefield to supplement and increase the firepower of ground arms is decidedly and incorrect employment of this class of aviation, since it would neglect the more distant and vital objectives (Finney, n.d., 157).

After the breakout of war in September 1939, the Air Corps was finally prompted to aggressively develop CAS technology and doctrine. The reason for the new sense of urgency was the highly publicized performance of the German Stuka dive-bomber in Poland and France. These events served as an external stimulus for change. Although the performance of the Stuka was questionable when facing moderate enemy air defenses, Gen. Arnold went forward with a program to acquire dive-bombers for its use. The Air Corps took delivery of modified Navy SBDs, they were designated the A-24 (Kennett, 1990, p 52). Gen Arnold, sending a letter to Gen. Andrews (Commander of the newly consolidated strike force) stressed "the vital importance of developing tactics and techniques necessary in rendering close air support (Arnold, 9 August 1940)." In this case, technology was adopted before the doctrine but at least there was an attempt to provide doctrine, unlike the A-20 case.

In the months that followed, many exercises were conducted to test doctrine, aircraft, munitions, radios and tactics. These exercises were plagued by a lack of equipment and general attention from the AAF. Determining how close bombing should occur to friendly troops was one of the objectives of the exercises. Tests indicated that the distance was dependent upon the skill of the pilot and that troops could not effectively direct CAS aircraft or designate targets. Those targets that were designated by ground personnel were considered not profitable (Kennett, 1990, p 53).

E. ORGANIZATIONAL CHANGE

The organizational structure of the U.S. Army and its air force played a key role in the ascendancy of strategic bombing doctrine and the neglect of the CAS mission. In the beginning of the interwar period, the Army naturally focused a lion's share of its attention on ground forces and acknowledged only a secondary concern for its air forces. The Army bureaucracy was not inclined, or even capable, of viewing the air force as anything but a supporting branch whose sole purpose was to support the ground forces. This is understandable considering that the leadership within the Army was made up of former ground commanders. Aviation was still in its early days.

As WWII grew closer and improvements in air bombardment capability increased (range and payload), the AAF became more important to U.S. military strategy. In 1935, the General Staff of the Army gave the AAF the authority to organize a combat ready air force. The Air Corps formed the General Headquarters (GHQ) Air Force in order to create a combat force (Greer, 1955, pp 44-106). This organizational change did allow the AAF more autonomy but it was still subordinate to the Army Chief of Staff. However, as the AAF grew, its leadership became more prominent in the military strategy debate. The growing voice of the air branch within the U.S. Army began to attract more attention from the ground-centered Army. Eventually, the AAF achieved enough influence to direct its own course (i.e. strategic air operations vice CAS). It was evident that the AAF and the AGF were still headed in different philosophical and doctrinal directions.

Ending the debate between the AAF and AGF once and for all, President Franklin D. Roosevelt called for a meeting of the top Army leadership in the White house. On 14 November 1938, the president stated that he wanted a force that would be capable of protecting the Western Hemisphere from the actions of Germany and Italy; he said that the Army Air Corps should be that force (Watson, 1950, pp 132-146). As a result of Roosevelt's order, Congress significantly increased the AAF budget. The AAF was now able to effectively maintain its position on the proper use of air power in support of ground forces. It could do this because of its new-found prominence in the War Department and increased budget from Congress.

Shortly after the budgetary increases of 1939 and 1940, General Arnold designated Col. William Lynd as the first head of the newly formed Air Support Section of the new Air Force Combat Command. Arnold made this organizational change to improve air-ground cooperation and to give ground commanders an advocate for air support. This all occurred when the AAF's attention was shifting even more in the direction of strategic air warfare (Arnold, 1949, pp 177-180).

Organizational changes in the U.S. Army were occurring at a quick rate as the nation prepared for war. Commanders on both sides of the CAS debate understood that the AAF mission was bigger than merely supporting the ground forces. The senior leadership in the AAF and AGF, Generals Marshall, McNair and Arnold, realized that the AAF was becoming its own service but did not want to separate the AAF from the AAF while war loomed. It was decided to reserve that change until after the war. In the mean-time, the AAF organized itself so that it could conduct strategic air operations while still supporting the ground forces.

F. CONCLUSION

At the end of WWI, the future of CAS seemed to be promising in the Army Air Service. The use of air power on the battlefield had yielded great results in 1918. Unfortunately, the U.S., for bureaucratic and budgetary reasons, did not continue the development of CAS doctrine and technology until just prior to and during the next world war. This late development of CAS would have serious effects on the battlefield. These effects, along with the further development of CAS doctrine will be discussed in the next chapter.

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IV. CLOSE AIR SUPPORT AND THE FORWARD AIR CONTROLLER

A. INTRODUCTION: WWII

The early years of America's involvement in WWII were costly. In Tunisia during the 1st months of 1943, the ground force commander had direct control over the air support command attached to his unit. This is what U.S. doctrine dictated. The AAF was still under the yoke of the AGF. As a result of this command structure, there were no coordinated efforts to gain air superiority. Instead, the Luftwaffe had control of the air. AAF losses were high and made the conduct of CAS impossible (Lester, 1997, p 10).

The unacceptably high losses of friendly forces in Tunisia made commanders realize that the command and control of AAF units needed to be changed. Undoubtedly, one of the best examples of the poor employment of AAF assets occurred during the Battle of Kasserine Pass. The American First Armored division was utterly defeated, losing 50 percent of its tanks, by Field Marshal Erwin Rommel's armored units supported by the Luftwaffe. Few AAF sorties supported this battle. How could the Allies be defeated so easily when their air forces outnumbered those of the Axis by three to one? Inter-Allied bickering was one reason for the defeat; Gen. Pete Quesada said of the infighting, "I was aware of the discord and rather distressed by it. It resulted in complete chaos in North Africa" (Hughes, 1995, p 86). Unfortunately, the allies were in the process of changing the command and control (C^2) of the AAF units when the Kasserine battle took place (Playfair, 1966, p 303).

Experience in Tunisia clearly shows that a smaller force with a good C^2 system can defeat a numerically superior force without an adequate C^2 system. Just a month before the Kasserine Pass debacle, Chruchill, Roosevelt, and the Combined Chiefs of Staff came together for the Casablanca Conference on 20 January 1943 (Syrett, 1995, p 170). The purpose of this conference was to rearrange the command structure of the Allied forces in the Mediterranean. It worked. Each day, the Allied air forces' C^2 and tactics got better against the logistically taxed and thinning Axis air and ground forces (Air Ministry, 1983, pp 249-54).

Before FM 100-20, innovations in the strategic bombing mission were sought after while innovations in CAS were at a standstill. This trend continued after the introduction of FM 100-20, "Command and Employment of Air Power," on 21 July 1943, but improvements in CAS slowly began to surface despite the inter-service argument. The U.S. entry into the war was a major catalyst for change. Although CAS needed a great deal of development and refinement, the three distinct missions of a tactical air force, defined in FM 100-20, proved to be completely sound during air-ground operations in the ETO. The three missions were: to gain and maintain air superiority, disrupt hostile lines of communication, and to destroy enemy troops and materiel on the fighting front in cooperation with forward ground forces (Kohn and Harahan, 1984, p 7).

The lessons learned from Kasserine Pass and other battles in Northern Africa were slowly building the doctrine and tactics of CAS. This incremental process of doctrinal development continued in the Sicilian and Italian campaigns. However, despite the Casablanca Conference and the introduction of FM 100-20, the AAF and AGF were still not working together effectively; organizational resistance to change, added to the lack of agreed upon doctrine, was probably the culprit. Speaking about the lack of air-ground coordination prior to the invasion of Sicily, General Omar Bradley complained,

> It certainly was inexcusable. We were preparing to assault an enemy beach in darkness, knowing full well that a panzer division was ready to pounce on us. It would have been immensely comforting to know positively that our massive air power would be overhead to help us if we needed it…We were soon to discover that our fears were not groundless. The air support provided us on Sicily was scandalously casual, careless and ineffective (Bradley and Blair, 1983, p 178).

By the end of the war in the ETO, after tremendous effort and CAS development, the relationship between the AAF and AGF had gotten decidedly better. The air and ground components of the Army, in conjunction with the Navy, had to work together in order to be successful against the Nazis. Field Commander of the 12th Army Group, General Omar N. Bradley, experiencing a complete change of heart, emphasized this relationship in a statement he made in Wiesbaden, Germany, on 15 July 1945:

> The axiomatic requirement that victory can only be achieved by the attainment of supremacy on the land, sea and in the air has never been so fully proven as in this total defeat of an enemy who never controlled the

> sea, who tried to substitute strategic artillery for a defeat in the air, and whose armed forces were crushed and homeland over-run by the combined power of our supremacy in all these three elements (Kohn, 1946, p 1).

It is interesting to note that the doctrine writers in Washington D.C. were reluctant to give the CAS mission a high degree of overall importance in the air power scheme of things. They were fixated on the development of strategic bombing doctrine. However, the air and ground commanders in the ETO saw how effective the use of air power could be on the battlefield. Both the AAF and AGF in the ETO worked diligently to innovate the CAS mission. The innovations that occurred in CAS were a mixture of "current technology/new concepts of operations" and "new technology/new concepts of operations" (Arquilla 2001). The AAF and AGF took the existing technology of the time, the aircraft and its information systems, and slowly developed new methods of employing them. They also incorporated new technologies, as they surfaced, into the existing systems and developed new concepts of operations as needed.

An important point to consider is that a culture of change and innovation was afoot in the U.S. Army. New ideas were no longer just nice to think about, ETO commanders enthusiastically sought them out and tested them in the field. In essence, changes in CAS were coming from the bottom up, despite the reluctance of the AAF commanders in Washington D.C. Incrementally, the AAF and AGF developed new doctrine, tactics, communications and signaling methods to help U.S. pilots locate and identify enemy units while, hopefully, avoiding friendly troops. Unfortunately, this was not always the case. As the AAF and AGF struggled to defeat the Germans, while simultaneously developing CAS doctrine and tactics, several hundred American troops were killed and wounded by friendly fire (most of them in the St. Lô breakout attempt) (Craven and Cate, 1948, p 233-234).

B. AIR-GROUND TEAM, A CULTURE UNTO ITS OWN

It was not long after the introduction of FM100-20 that the once opposed AAF and AGF started to envision themselves as an air-ground team. Close cooperation between AAF and AGF commanders in the ETO was essential to make the CAS mission work well and reduce friendly fire casualties. The problem of how to make the two forces work together efficiently, with the greatest lethality to the enemy, was the over-riding issue facing the commanders.

The Ninth Air Force, the numbered air force responsible for all close air support missions in the ETO, devised and maintained an extensive air-ground exchange program. This program was not just a simple liaison program; the exchange of thousands of officer and enlisted personnel between both air and ground commands was highly successful (Kohn and Harahan, 1984, p106). The exchange program allowed the personnel involved to develop a sense of understanding about their sister branch's capabilities and limitations. This, more than anything, fostered a greater atmosphere of cooperation. The creation of air-ground cooperation parties (AGCP) was just one of these exchanges that allowed the AAF and AGF to conduct combined operations more effectively. The AGCP was made up of Air Corps advisors who were placed with ground units (Headquarters, MAAF, 1945).

The AGF and AAF commanders understood their roles to be members of an overwhelming team whose mission it was to crush the outer defenses of "Fortress Europe." Once the invasion of Normandy was complete, the air-ground team focused its efforts on the breakout from Normandy and subsequent defeat of Germany. The combination of the 12th Army Group and Ninth Air Force resulted in an unstoppable team. The pace of the thrust through Europe was aggressive (after the breakout of Normandy); when asked about protecting the flanks of such a fast moving army, Patton said,

> …this lack of defense is immaterial. If I had worried about flanks, I could never have fought the war. Also, I was convinced that our Air Service could locate any groups of enemy large enough to be a serious threat, and then I could always pull something out of the hat to drive them back while the Air Force in the meantime delayed their further advance (Patton, 1947, p 112-13).

Defying most expert opinion, this air-ground team quickly destroyed the once invincible German army in Western Europe. However, this victory came out of great sacrifice and much trial and error.

C. ST. LÔ

After the invasion of Normandy, Allied movement to the East was halted. Difficult terrain (hedgerow country), muddy conditions, and stiff German resistance made further progress impossible. Gen. Bradley devised a plan called Cobra to proceed in conjunction with Gen. Montgomery's diversionary plan called Goodwood. The goal of Cobra was to effect the breakout of Normandy. The breakout was planned for the St. Lô area. Cobra was to rely upon the saturation bombing of an area of German concentration that was a rectangle three and a half miles wide and one and a half miles deep. The St. Lô-Périers road marked the Northern side of this rectangle. The AAF had to be very accurate in the saturation bombing because American troops were going to be advanced to the St. Lô-Périers road for the jump-off and breakout through St. Lô area (Bradley and Blair, 1983, p276-277).

The saturation bombing in support of the breakout in St. Lô was to be the most novel and aggressive use of air power to date in the war. While briefing the AAF top brass, General Bradley and Quesada attempted to finalize the plan for Cobra. Bradley asked for a force of 1,500 bombers for the attack, General Leigh-Mallory promised him 2,246 airplanes (Hansen, 1944). The one element of the plan that was not settled (sources contradict each other on this point) was the approach path that the bombers would use. Bradley asked (and assumed he got it) that the planes would proceed parallel to the St. Lô-Périers road (Bradley and Blair, 1983, p 276). The AAF generals never agreed to this approach path, claiming that it exposed their airplanes and crews to unacceptable flak (Hughes, 1995, p 200). They wanted to approach the rectangle perpendicular to the St. Lô-Périers road, thus giving their bombers more room and protection. Perhaps Bradley overlooked the miss-coordination of approach paths because he was overly encouraged by the increase in bombers. Whatever the reason, this misunderstanding would prove disastrous.

After several days of delay due to rain and poor runway conditions, General Leigh-Mallory gave the order. Thousands of bombers and fighters took of from England and struggled to form into the myriad formations required for the attack. Because of weather concerns (cloudiness over England and France) and second-guessing, Leigh-Mallory recalled the aircraft, cancelled the recall and then recalled them again. The result was all but a few of the heavy bombers returned and half of the fighters (Hughes, 1995, p 206). In St. Lô, the American troops, who previously withdrew to safe positions, got the cancellation order and returned to the front lines; they were unaware of the approaching armada. (Bradley and Blair, 1983, p 279)

As the bombers appeared in France, it was only a matter of minutes before the devastation began. The uninformed bombers started their drops. While most of the bombers delivered their ordnance in the strike zone, some of them did not. Some were as far as 2000 yards off (Craven and Cate, 1948, p 233). The unwarned American front line troops were scattered by the ensuing chaos. There were 156 American casualties, 25 of those were killed. Bradley and Quesada were shocked; they were surprised to see the bombers but even more astounded that the bombers made their approach perpendicular to the St. Lô-Périers road. When asked about the approach, Leigh-Mallory said that the Eighth Air Force had made no mistake. They claimed the perpendicular approach was the only way to get all the bombers through in Bradley's timeframe. Recounting the events later, Bradley stated,

> To my astonishment, the Air Force brass simply lied, claiming they had never agreed to bomb parallel to the road. Not only that, they put me over an impossible barrel. They would not mount a second attack except perpendicularly to the to the road. Fearing the Germans were onto us, I had no choice but to accept what the airmen offered and we reset the jump-off for the following day, July 25 (Bradley and Blair, 1983, p 279-80).

On the 25th of July, the bombers returned, again on a perpendicular approach, and once more the bombs fell short. The first of the heavy bomber waves hit well within the strike zone. The last wave, whose target area was obscured by dust and smoke, dropped its bomb load on American positions. All in all, 111 Americans were killed and another 490 wounded on the second day of bombing (Hughes, 1995, p 215). The Germans fared far worse. No fewer than 1,000 men died, communications were completely disrupted, scant few tanks and tank destroyers survived and the troops who were not dead or wounded were in shock. Very little resistance was offered to the advancing American troops (Bradley and Blair, 1983, pp 280-81).

Ironically, one of the Americans killed by AAF bombs was General Leslie McNair, Commander of the American Ground Forces (Patton, 1947, p 95). The air-ground team obviously needed more refinement. One step they took was thorough procedural and organizational change.

C. ORGANIZATION

During the breakout of Normandy, the Ninth Air Force, under General Hoyt Vandenberg, consisted of three TACs: IX, XIX, and XXIX. The Ninth Air Force's equal on the AGF side was the 12th Army group under General Omar Bradley. The TACs maintained partnerships with their associated field armies: the 1st, 3rd, and 9th. Each TAC had anywhere from four to eight fighter-bomber groups and one reconnaissance group attached to it (Lester, 1997, p 11). The number of fighter-bomber groups varied due to the fluid nature of the Ninth Air Force organizational concept. The fighter-bomber groups could be moved as needed.

The TAC was responsible for coordinating with its associated army component for all fighter-bomber reconnaissance operations. The TACs were granted a great deal of autonomous authority to conduct operations in conjunction with their army counterparts, but the Ninth Air Force always retained the ability to reapportion forces where they were needed. The flexibility inherent in this system allowed the Ninth Air Force to change its structure on an ad hoc basis to fit the operational requirements. This approach to military organization was unique. The flat nature of the organizational structure allowed a great deal of lateral control and communication within the Ninth Air Force. Also, the thorough integration of liaison officers at all levels of the 12th Army Group and Ninth Air Force command structure helped enabled the Ninth Air Force to structure itself in such an unusual way. This structure helped create a very effective air-ground team (Kohn and Harahan, 1984, p 8-9).

Maj. Gen. Elwood Quesada, Commander of IX Tactical Air Command (TAC), recognized the need for liaison officers at all levels of the AAF and AGF organization. Quesada did this by collocating his headquarters with General Bradley's. He insured that adequate numbers of liaison offers were assigned at every command level to facilitate information flows and properly integrate air power into the ground battle plans. Quesada, like the other TAC commanders, operated a joint operations center (JOC) or combined operations center (COC) to provide C^2. An experienced combat fighter pilot ran the JOC as the combat operations officer. Usually a senior Army officer, Naval liaison officer, and intelligence officers kept track of the current air and ground situation for the JOC (Lester, 1997, p 11). Finally, a tactical air control center (TACC or TCC depending on the referenced source) carried out the directives of the JOC and was responsible for all offensive and defensive missions within its geographic area. The maximum range of the TACC's radar coverage defined this area (Clark, 1944, p 258 and Kohn and Harahan, 1984, p 105). The forward director post (FDP) also had radar that could extend the TACC's range of control. The following diagram (Figure 6.) illustrates the overall organizational structure in action:

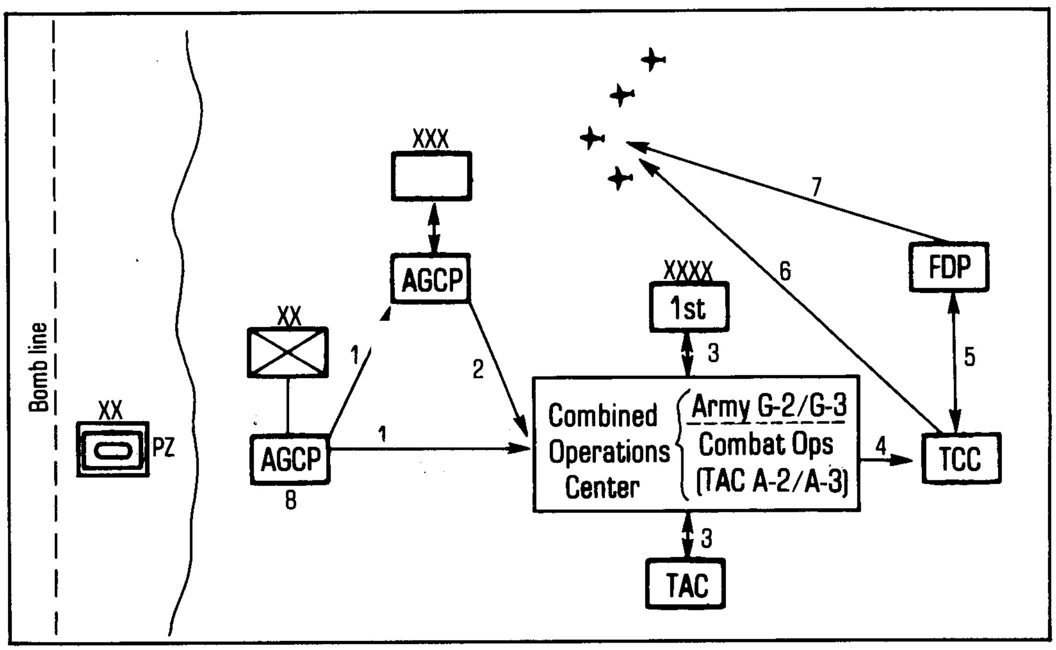


Figure 6. Tactical Air Command Immediate Support System, Summer-Fall 1944. (From: Hallion, 1989, p 198)

The following list will explain the air-ground CAS control process via the numbered sequence in Figure 6.:

1. Division Air-Ground Coordination Party (AGCP), staffed by Tactical Air Party Officer (TAPO) and Division G-3 (Air), send direct support

request to Army G-3 at COC, also informing Corps G-3 (Air) so Corps AGCP can monitor or intervene as necessary.

2. Corps AGCP monitors communications net.

3. COC, consisting of Army G-2 and G-3 together with TAC's A-2 and A-3 (termed combat operations), consults with Army HQ ad TAC HQ on request; then G-3 and A-3 each approve it.

4. A-3 at Combat Ops relays support request and recommended course of action to TCC, also termed fighter control center.

5. Forward Director Post (FDP), in constant communication with TCC, provides continuous updates on location of friendly and enemy air units using microwave early warning (MEW) radar tracking.

6. TCC relays strike request to airborne on-call fighter-bombers.

7. FDP, using SCR-584 radar, furnishes precise guidance and navigation information to en-route strike flight.

8. Division AGCP prepares for incoming strike flight by artillery fire to mark targets with colored smoke and to suppress enemy air defenses; AGP will maintain communication with strike flight during attack (Hallion, 1989, p 198).

One reason that CAS became successful in the ETO was due to the afore-mentioned organizational structure. It afforded on-the-spot interchange and coordination of air and ground information. The co-location of ground and air commanders and their staffs was essential for joint planning to be conducted and decisions made in near real-time. The air and ground headquarters maintained this close physical proximity from the TAC-army level upward for the remainder of the war. It was that flexible and responsive organizational structure that improved CAS after the breakout of Normandy. In essence, the air and ground elements were networked together in a non-traditional way.

D. COMMUNICATIONS

Communications improvements had the greatest impact on CAS innovation. Before radios became standardized equipment between the AAF and AGF, AGF units used fluorescent panels and colored smoke to mark the front lines for CAS aircraft. The Germans first used colored panels and smoke in 1939 when its dive-bombers had difficulty distinguishing who was who on the ground. The rapidly moving Panzer units made the traditional "front line" obsolete (Murray, 1990, p 85). This practice was used a great deal by the Americans later on in the war. They did this out of fear of being mistaken for enemy units and subjecting themselves to friendly fire. However, the markers sometimes gave away their positions. The widespread use of these signaling methods occasionally confused the pilots and they could not distinguish the front lines of battle.

The AGF soon developed new ways of marking the enemy and new procedures to avoid friendly fire. One way the AGF marked the enemy was to coordinate the deployment of smoke shells with approaching CAS aircraft. When the aircraft came into visual range, artillery units would fire smoke shells onto the enemy's position (Hallion, 1989, p 198). This method enjoyed some success (to be discussed in a following section), but it required the presence of artillery. Also, when the artillery would fire the smoke shells, it would give away its own position, thus eliminating surprise. There was a better way to coordinate CAS. That was through the use of the radio.

Initially, HF radios were used on AAF aircraft. However, they were not compatible with AGF VHF systems. As previously mentioned, the Army developed various visual signaling systems and procedures to aid pilots in target location and avoidance of friendly forces. Despite great improvements in signaling and spacing of forces clear of bombing zones, friendly fire casualties persisted. It was not until the introduction of VHF radios in the aircraft that real progress in CAS occurred. Introduction of VHF radios in CAS aircraft allowed ground units to talk directly with their supporting aircraft, greatly improving their accuracy while all but eliminating friendly fire casualties. The capabilities gained from the introduction of the VHF radios in the air were enhanced even more by the introduction of skilled controllers on the ground. The introduction of this new technology helped to produce a new concept of operations (Hallion, 1989, p 200).

Another area where communications improvements were made was in the use of radar. The Ninth Air Force used Microwave Early Warning Stations (MEWS) and SCR-584 control radars at forward director posts to guide planes into close proximity of friendly troops engaged with the enemy (Crane, 1993, p 70). Line-of-sight beaconing systems such as SHORAN were used as well as GEE, a beaconing system that used triangulation to help the pilots locate their position (Crane, 1993, p 74). These systems were a great tool for the tactical air force, especially in winter months when visibility was poor due to weather. Because of these advances, as well as advances in tactics, the Ninth Air Force operated in support of the advancing armies from 1 October 1944 to 9 May 1945 without a break. CAS accuracy increased and AGF losses due to friendly fire were greatly reduced (Reed, 1984, p 34). General Patton, who was a big proponent of CAS, commenting on the use of radar said:

> A very fine feat of air co-operation occurred on the twenty-fourth. Five tanks of the 4th Armored were being attacked by some twenty-five German tanks, and the only thing we could send to their help was air. The weather was unflyable according to all standards, but General Weyland ordered two squadrons to attack. This they did, being vectored in by radar at a height of not over fifteen feet from the ground. Having located the enemy, they skip-bombed and also strafed him. While this fighting was going on, the pilots had no idea that they could ever land and yet carried out their job magnificently (Patton, 1947, p136-37).

E. FORWARD AIR CONTROLLERS (FAC)

> "One look is worth one hundred reports." General George S. Patton, Jr. quoting a Japanese proverb (Patton, 1947, p 97).

Before discussing the role of the FAC during the breakout of Normandy, it is important to point out some of the early uses of this concept in WWII. There were two systems of forward air control that the AAF tested during the Italian campaign: Horsefly and Rover Joe. Horsefly consisted of an L-5 observation plane flown by an artillery-spotting pilot. The pilot would direct fighter-bombers to targets of interest when artillery was not available to hit those targets. This system evolved as the war progressed. By June 1944, the L-5 was equipped with the SCR-522 radio. A strike pilot, accompanied by an infantry officer to help differentiate between friendly and enemy troops, now flew the L-5. The TACs used the L-5 in this capacity until the end of the war (Hallion, 1989, p 181-82).

Another FAC experiment that took place in Italy, thus laying the foundation for FAC development in the breakout of Normandy, was called Rover Joe. Rover Joe consisted of an experienced fighter-bomber pilot and a radio. The Rover would position himself in a location where he could see the whole battlefield. From this position he would call in air strikes on enemy locations. The CAS aircraft would consist of flights of four aircraft and were assigned to the Rover every 30 minutes. Rover Joe could effectively describe targets to the pilots and warn them of enemy defenses (HQ MAAF, 1945, Tab D). Speaking about the effectiveness of Rover Joe, Gen. Mark Clark noted, "Frequently, Rover Joe will put bombs on targets within 1,000 yards of our troops, and not once have any of our men been hurt" (Clark, 1944). The Ninth Air Force developed its system of forward air control from the Rover Joe concept, capitalizing on ever-improving communications technology.

While the addition of VHF communications in CAS aircraft was an incremental technological change, it transformed the CAS mission (Jacobs, 1990, p 263). Most ground units had a least one FAC to enhance CAS effectiveness. Since the FAC was capable of speaking directly with the CAS pilots (or via the TCC), Gen. Quesada logically concluded that the FAC ought to be a knowledgeable AAF officer (Jacobs, 1990, p 271). He reasoned that if his men and airplanes were going to get in close on the battlefield, he wanted someone who could speak the aviator's lingo directing them in. In effect, Quesada decentralized the IX TAC target assignment function. This innovation and level of understanding that Gen. Quesada applied to the information system between the pilot and FAC was extraordinary.

Using this logic, General Quesada developed the concept of armored column cover (ACC) (Hallion, 1989, p 199). The creation of the ACC concept grew out of a deal that Quesada made with Gen. Omar Bradley before the St. Lô breakout attempt. Before this deal was made, Bradley was very skeptical of the AAF's trustworthiness (as previous quotes point out). Despite his attitude about the AAF, Bradley and Quesada had a very good personal and working relationship (Hallion, 1989, p199). Sensing Bradley's misgivings about committing to his army to the St. Lô breakout, Quesada offered to place a FAC and radio with his armor units. By guaranteeing air support to Bradley's army in this way, Quesada was setting the stage for air-ground cooperation for the remainder of the war in the ETO.

Quesada's ACC concept, in practice, outfitted the lead M4 Sherman tank in each armored column with an SCR-522 VHF radio and one FAC. The tank commander used an SCR-528 VHF radio to communicate with the other tankers in the column (Hallion, 1989, p 200). The ACC received continuous air cover, protecting it from enemy fighters and ground fire, while the FAC could direct CAS to specific targets in front of the formation. The column cover aircraft (column cover flight) usually consisted of four P-47's. The P-47 flights were relieved every 30 minutes while the armored column operated. The P-47's not only sought out targets on the ground, they also performed the role of air defense against attacking Luftwaffe aircraft. The effectiveness of ACC and FAC was so great that it went unchanged until the end of the war in the ETO.

Recounting an instance of air-ground cooperation in the form of ACC, General Patton said,

> About an hour before sundown we received a report that an armored column was fifteen kilometers southwest of Rennes, moving in rapidly. I asked General Weyland, commanding the XIX Tactical Air Command, to send some fighter-bombers to stop it. The bombers were unable to find the column, because it actually was the 4th Armored Division moving in from the northeast. However, the planes did some very effective work knocking out enemy resistance ahead of the 4th Armored Division and this was the precursor of many other such jobs. It was love at first sight between the XIX Tactical Air Command and the Third Army (Patton, 1947, p 99).

General Patton was a true believer in air-ground cooperation. He believed that the team made up of armor and fighter-bombers was almost unbeatable. He theorized that fast moving armor prevented enemy units from moving off the road and thus deploying. If the enemy stayed on the road than it was easy prey for the fighter-bombers. He went on to say that two things were required to make the armor and fighter-bomber team effective. The first thing was intimate friendship and confidence between the air and armor. This friendship and confidence was reinforced by the FAC's co-location with the tank commander and his ability to communicate with the CAS pilots overhead. The second requirement that Patton discussed was incessant and apparently ruthless driving on the part of the ground commander. Patton said, “A pint of sweat saves a gallon of blood.” Patton’s affinity for CAS is reflected in the following statement,

> Just east of Le Mans was one of the best examples of armor and air co-operation I have ever seen. For about two miles the road was full of enemy transport and armor, many of which bore the unmistakable calling card of a P-47 fighter-bomber – namely, a group of fifty-caliber holes in the concrete. Whenever armor and air can work together in this way, the results are sure to be excellent (Patton, 1947, p108).

A committee composed completely of ground officers (the Air Effects Committee of the 12th Army Group) submitted a report concerning ACC operations, the report stated:

> Armor column cover…was of particular value in protecting the unit from enemy air attack and in running interference for the spearhead of the column by destroying or neutralizing ground opposition that might slow it down or stop it…

The report went on to say,

> The decision of the Ninth Air Force to give high priority to armored column cover in a fast-moving or fluid situation from the breakout in Normandy to the final drive across Central Europe made a successful contribution to the success of the ground units in breaking through and encircling the various elements of the German armies…[after addressing immediate support needs] the flight leader patrolled ahead of the armored column, as deep as thirty miles along its axis of advance, in an intensive search for enemy vehicles, troops or artillery. This effort permitted our armor far greater freedom of action than would have been otherwise possible (Bradley and Air Effects Committee, 1946, p41-42).

It was clear that the ground commanders saw the incredible utility of CAS in the ETO. The addition of the FAC, especially in the ACC role, was an extremely effective innovation in CAS tactics. It is interesting to consider the pilots’ point of view. The next section will elaborate on what the pilot’s thought about CAS and FACs in the ETO.

F. FAC: PERSONAL ACCOUNTS FROM AMERICAN CAS PILOTS

Veteran fighter-bomber pilots provided the information about CAS, FAC and their communication systems in the following section from WWII. The information was obtained through interviews conducted on electronic mail and through telephone conversations. Although the interviews were informal, the accounts of the interviewees were very enlightening and highly relevant to this chapter. I have selected three former fighter-bomber pilots and some of their insights for this section.

1. Robert V. Brulle

Robert Brulle served with the 390th Squadron in the 366th Fighter Group, flying P-47 Thunderbolts in a CAS role. He completed 70 combat missions. During this time, he was responsible for destroying a very large amount of German war materiél. While flying most missions in a CAS role, Brulle had one encounter with German aircraft. On 1 January 1945 he shot down a FW-190. Brulle also conducted armed reconnaissance missions while serving in WWII.

In addition to Brulle's actions as a fighter-bomber pilot, he spent two weeks as a FAC riding in an ACC tank. Many fighter-bomber pilots were rotated into two-week long FAC duties. In Brulle's words," I spent two weeks in a tank as a Forward Air Controller, which I did not like at all! We [fighter-bombers in general] dive bombed and strafed very close to our own troops several times. I do not think we ever bombed them but the ground forces shot at us many times." During their two-week duty as an ACC FAC, many of the fighter-bombers like Brulle saw how effective CAS was from armor's perspective. Brulle did say that the pilots thought the "FACs were great and led them right to the target." It is interesting that Brulle expressed distaste for being a FAC; that comment suggests that the fighter- bombers provided extremely close support to the ground forces. One thing that Brulle remembered about signaling with colored panels, "The panels worked great but sometimes the Germans displayed captured panels and confused us. Brulle, like the other fighter-bomber pilots preferred the radios and ACC system (Brulle, 10 March 2002).

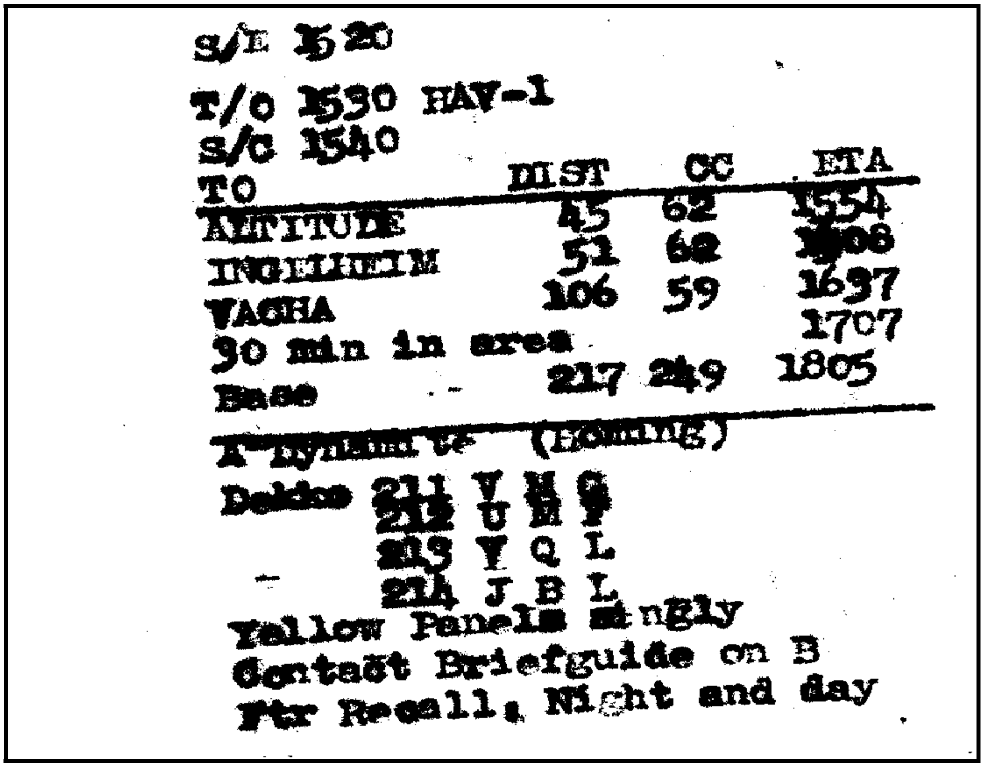
Robert Brulle also commented on the use of radar. He said that they ran "Pickle Barrel" missions, their code name for radar directed attacks, quite often. He recalled that they did not have a lot of confidence in the radar system. This was his belief until he was on a mission and saw a hole open up in the cloud layer and saw his bombs hit the target. He did say that for most missions they did not use radar guidance directly; the type of CAS missions he performed did not require radar because he could see his targets up close (Brulle, 11 March 2002).

Robert V. Brulle continues to be active in the aviation field. He just finished a book on this subject entitled, *Angles Zero: P-47 Close Air Support in Europe.* He is currently finishing a second book about his 50-year adventure in the aviation industry; in it, he will address young engineer's reliance on computers and technology. He states that, "They feel it [technology] is a panacea, but in reality it is only as good as the data put in by a human hand. I think we may be placing too much emphasis on technology and not enough on people." It may be beneficial for the current generation to heed the words of this wise Thunderbolt pilot (Brulle, 11 March 2002).

2. Vernon Truemper

Vernon Truemper is the current president of the 367th Fighter Group Association. Truemper started out flying the P-38 Lightning and then his unit changed over to the P-47. He remembers doing most of his support for Patton's Third army and for the 4th Armored Division. He recounted doing ACC missions similar to those of Robert Brulle. He also noted that he clearly remembered the yellow or cerise panels that the American ground troops covered their armor with. He said that the panels were a very good signaling method to the pilots above. On the issue of FACs Truemper said, "We became very friendly with the FACs, and relied on them very much. I can never recall being directed by radar. Since we did not use it a lot we never knew enough to have a high level of confidence in it. The panels worked well for us although we did rely on voice communication with the FAC in conjunction with the panels" (Truemper, 12 March 2002).

Vernon Truemper provided a digital image of a Dynamite Gang (nickname of his squadron) "crib sheet" or "mission slip" that he and the other fighter-bomber pilots used on every mission. During the mission briefing, the Intelligence Officer (IO) would provide them with these slips. Figure 7 is an example of one of Vernon Truemper's crib sheets:



S/E 1520
T/O 1530 HAV-1
S/C 1540

TO	DIST	CC	ETA
ALTITUDE	45	62	1554
INGELHEIM	51	62	1608
VACHA	106	59	1637
30 min in area			1707
Base	217	249	1805

(HOMING)
Dekko 211 V M G
212 U M [illegible]
213 Y Q L
214 J B L
Yellow Panels singly
Contact Briefguide on B
Ftr Recall, Night and day

Figure 7. Vernon Truemper's Crib Sheet. (From: Truemper, 12 March 2002)

The following will describe the contents of the crib sheet depicted in figure 7:

S/E: 15:20 = START ENGINESAT 3:20 PM

T/O: 1530 = TAKE OFF AT 3:30 PM

S/C: 15:40 = START COURSE AT 3:40 PM

The sheet instructed the pilots to reach altitude at a distance of 45 miles with a compass course of 62 degrees. (A base altitude was given and they would refer to their altitude as angles or devils whether above or below the base altitude. The sheet shows an estimated time of arrival (ETA) of 1554. At 1554 proceed to INGELHEIM, a distance of 51 miles with a compass heading of 63 degrees, ETA of 1606. Next, proceed to VACHA, distance of 106 miles and compass course of 59 degrees, ETA 1637.

Next, remain in the area for 30 minutes. The 3rd Army contact is "Briefguide" on channel B. Their armor and trucks will display yellow panels singly. Targets will be received from them.

The CAS aircraft would return to base, a distance of 217 miles on course heading 249 degrees with an ETA of 1805. Home base contact was "Dynamite" on channel A. If something should necessitate a recall, the fighter recall code was "Night and Day."

Dekko identified their squadron (393rd fighter squadron in this case). The numbers identified the flight and the letters identified the person when talking to Dynamite or Briefguide (Truemper, 12 March 2002).

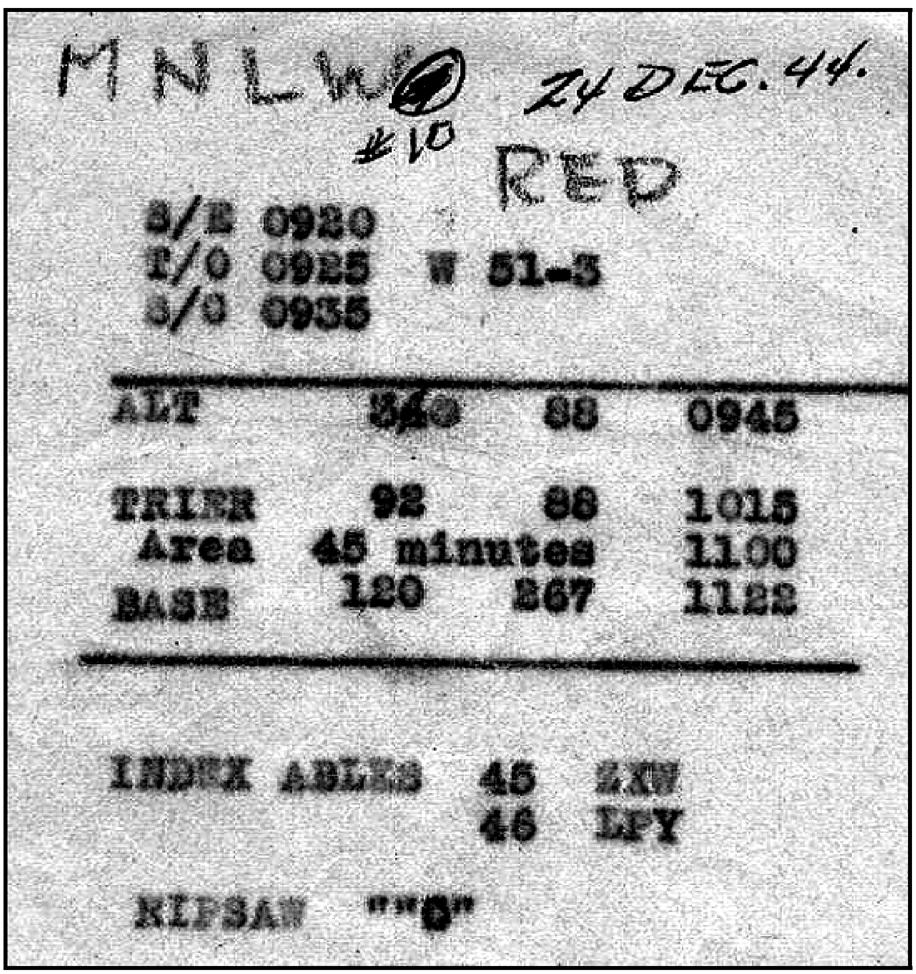
3. Jack T. Curtis

Jack Curtis also flew P-47s in the 367th, The Dynamite Gang, along side Vernon Truemper. Curtis regarded the P-47 as "an excellent ship for close support." He says that a lot of the pilots in his group were assigned FAC duties with the armor and infantry. He said that at first (immediately after the landings at Normandy) there were a lot of problems coordinating with the ground troops and that there were several cases of friendly fire casualties. He expressly remembered the friendly fire casualties that occurred at the breakout of St. Lô. Curtis also mentioned that General Pete Quesada was the "kingpin" on getting the coordination right.

Curtis had an interesting memory about conducting an airborne FAC mission that was similar to the Horsefly missions in Italy. It was shortly after his squadron shifted from flying the P-38 to the P-47 in February 1945. He was put in contact (by a ground controller) with an L-5 artillery forward observer. Because of light flak, the L-5 could not get in close enough to perform his mission. So, the L-5 observer asked Curtis to adjust the Corps' artillery in his stead. The L-5 observer gave Curtis the coordinates of the target and Curtis asked the Corps artillery for one round of white smoke for reference. Curtis observed the white smoke and made two adjustments for the artillery and asked for "Fire for Effect!" Curtis said that he was "flabbergasted by the destruction that those big guns had on the German 88 positions."

Curtis also remembered doing some blind bombing missions. Ground controllers led these missions using bombsights that traveled over charts (following the CAS aircrafts' movements) of the area to be bombed. Curtis recalls that these missions were not very successful and they did not like them. Again, this was due to lack of confidence in radar.

Jack Curtis also provided a copy of a mission slip; it is a bit clearer and a little different than Truemper's in Figure 7. At the bottom of the slip is RIPSAW. That was the name of the radar controller who was located near the bomb line. He was on VHF channel C. The letters at the top indicated that the planes were lettered M, N, L and WB. M was the flight leader, N was his wingman (Curtis's plane), L was the element leader and WB was his wingman. RED was the name of their flight. INDEX ABLES were challenges in case a transmission needed verification that it was not a German trying to lead them astray. They would challenge a transmission by saying: INDEX ABLE 45 and the reply would have to be ZXW spoken phonetically. The INDEX ABLES were changed daily. These are displayed as figure 8 below:


MNLWB 24 DEC. 44.
#10
RED

S/E 0920
T/O 0925 W 51-3
S/C 0935

ALT	3[illegible]0	88	0945
TRIER	92	88	1015
Area	45 minutes		1100
BASE	120	267	1122

INDEX ABLES 45 ZXW
46 EPY

RIPSAW ""C""

Figure 8. Jack T. Curtis' Mission Slip. (From: Curtis, 9 March 2002)

On this particular mission, the 12 American aircraft (all P-38s) were jumped over Trier by FW-190s. RIPSAW, the ground controller, warned them that the bogies were approaching, giving them time to prepare to fight. Curtis recalls that things got very busy for the next 20 minutes. Unfortunately, they lost one pilot, KIA, and another was shot down and spent the rest of the war as a POW. The American shot down six FW-190s that day. Also of note, this took place during the Battle of the Bulge. During the first week of this battle, the effectiveness of CAS was limited due to weather. However, when the skies cleared, CAS scored heavily against the Germans (Arquilla, 2001).

Curtis also recalls that the radio communications were usually ok. Sometimes they had troubles, especially when the Germans were jamming the signals. The 367th was named the Dynamite Gang because their communications and direction finders had the call sign Dynamite. (Curtis, 9 March 2002)

G. AIRCRAFT

The P-47 was the main aircraft used for the CAS mission. As previously mentioned the P-38 was flown in a CAS role but the P-47 was much more capable. Normally, a squadron of twelve aircraft was assigned the CAS role. Eight of the twelve P-47's were armed with two 500-pound bombs. The four remaining P-47's, armed for strafing, provided protection from German fighters and ground fire. When all 500-pound bombs were expended, the aircraft would strafe enemy positions with its eight-.50-caliber machineguns or conduct reconnaissance behind enemy lines.

The P-47s provided very effective ground support for the advancing allied forces as they drove deeper and deeper through France and on into the heart of Germany. The Thunderbolt's heavy machineguns and bomb-loads were extremely effective at eliminating enemy forces standing in the way of the allied advance. All of the veteran fighter-bomber pilots interviewed for this chapter preferred the P-47 to the P-38. One of the reasons the P-47 was superior to the P-38 (as well as the other friendly and enemy planes in the ETO) was its air-cooled engine. Most airplanes of that time had water-cooled engines which were vulnerable to flak and small arms fire. The P-47 could take substantial battle damage and still remain airborne (Hallion, 1989, p 202). The P-47 and

P-38 are pictured in Figure 9. The P-47 pictured is the variant that still had the framed canopy. Newer versions used a bubble canopy that gave much better visibility:

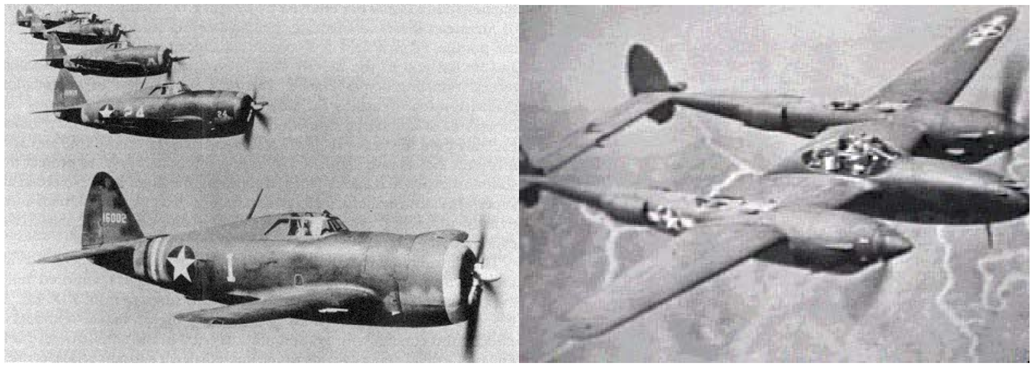


Figure 9. P-47 Thunderbolt (Left) and the P-38 Lightning (Right). (From: Wagner, 1982)

H. GERMAN REACTION TO AMERICAN AIR POWER

As Germans were being driven back into Germany, there was no doubt that American close air support was taking its toll on Germany's army. In a letter to his wife, Field Marshall Rommel wrote, "The enemy's air superiority has a very grave effect on our movements. There's simply no answer to it" (Ruge, 1979, p 181). It is very interesting that Rommel concluded, after witnessing American CAS tactics, that, "the tactical Luftwaffe has to be an organic part of the army, otherwise one cannot operate." This is interesting because it shows that the Germans, at least Rommel, did not understand how the AAF evolved. He did not understand that the reason the AAF were so effective was because they were no longer organic to the ground forces.

Ironically, CAS ended Rommel's participation in the war. As Rommel returned from a trip visiting an SS armor unit, his car was strafed. His driver was killed and the car went off the side of the road. Rommel sustained a head injury after being thrown from the car. He returned to Germany to recuperate. A short time thereafter he took his own life after being implicated in Hitler's assassination attempt (Hallion, 1989, p206).

As a diversion for the impending American breakout from St. Lô, General Montgomery's Operation Goodwood began with a huge air armada attack on German positions. It started at dawn and consisted of over 2100 aircraft. The attack went on for four hours and had devastating effects on German troops and equipment. The air prelude to Montgomery's ground offensive was decisive (Carell, 1963, pp 224-225).

General Bayerlein, commander of the Panzer Lehr Division, suffered through a similar air strike during the St. Lô breakout. More than 2000 bombers and over 400 fighter-bombers attacked his positions. The attack turned the Panzer Lehr and 13th and 15th Parachute Regiments into a "corridor of death four miles wide and two miles deep" (Carell, 1963, p 232). After the initial air attack, one of Bayerlein's lieutenants gave the following reconnoiter report to him: "I did not find a single strongpoint that was intact. The main fighting line has vanished. Where it used to be is now a zone of death" (Carell, 1963, p 234).

Later that same day, General Bayerlein was given an order from Field-Marshal von Kluge, Commander in Chief West, that ordering him to hold St. Lô at all costs. The order was verbally delivered by one of von Kluge's general staff officers. Bayerlein was angered by the order and ferociously retorted to the staff officer:

> Out in front everyone is holding out, Herr Oberstleutnant [lieutenant-colonel, staff officer]. Every one. My grenadiers and my engineers and my tank crews – they're holding their ground. Not a single man is leaving his post. Not one! They're lying in their foxholes mute and silent, for they are dead. Dead. Do you understand? (Carell, 1963, p235)

After the breakout from Normandy, Allied fighter-bombers made it very difficult for the German army to move during daylight hours. One incident that really demonstrates this occurred when General Meindl, Commander of the 2nd Parachute Corps, was driving back to his headquarters. Over the course of the nine-mile drive, he was chased out of his vehicle by fighter-bombers 30 times. The once 30 minute trip took over four hours to complete. He was lucky to make it back alive and uninjured (Carell, 1963, p 237).

The next day, General Meindl, like Bayerlein, was visited by one of von Kluge's staff officers (this time it was von Kluge's son). The reason for the visit was to order Meindl to conduct a daytime tank attack against the advancing Americans. Having just been harassed by fighter-bombers the day before, Meindl shouted at von Kluge's son:

> If your father knew what it means to operate against an enemy with a downright fabulous command of the air, then he would know that our only chance of doing anything useful at all is by attacking at night. Tomorrow's tank attack is going to be a failure, because it is scheduled on too broad a front and because it isn't going to start until dawn, which means it will take place in daylight. Those tanks are destined to be smashed. And all that's left for the grenadiers to do is to lie down and sacrifice their lives. It's heartbreaking to stand by and watch (Carell, 1963, p 238)!

General Meindl was correct. The Americans were far too powerful in the air and the ground. The Germans did start moving their units by night to avoid the fighter-bombers, but it only delayed their eventual destruction. Any German activity conducted during the daytime was done under the hopes of bad weather – bad weather was one of the only things that covered them from the eyes and ordnance of the fighter-bombers.

I. CONCLUSION

Innovation to the CAS mission in the ETO was slow in coming. It did not really take place until the 1943-1944 time frame. Existing technologies of the period were used while new concepts of operations were slowly incorporated. Some incremental changes in technology occurred (addition of the VHF radio into aircraft and use of radar) but did not cause the overall change in operational philosophy. The VHF radio did enhance the overall effectiveness of CAS but the search for new CONOPS was already in progress. The introduction of the FAC and ACC concept, combined with radar and radio technological improvements created a revolution in CAS tactics and doctrine. The technology combined with the human operators resulted in a system that helped the Allies win the war in the ETO.

Fortunately, the AAF and AGF commanders in the ETO had the ability to step above their individual services' cultural biases and hammer out a new concept of operations in CAS. It is also worth noting that innovation can occur from the bottom up in an organization even when doctrine would seem to prevent this from happening. It may even be interesting to evaluate if top down innovation efforts are even fruitful, as with the current RMA. Finally, I would like to point out the clear effectiveness that the ACC and FAC (a small and mobile unit), combined with a relatively reliable information system (the VHF radio and radar), had on the battlefield in CAS. It is interesting that a small unit of maneuver, combined with an effective information system, manned by human beings who could employ it, was the locus of a great innovation in military tactics and doctrine back in WWII.

The next chapter of this thesis will examine current manifestations of CAS. Operations in Afghanistan as well as recent training operations with CAS and FAC will be included in this examination. Similarities and differences between current CAS/FAC implementation and those that occurred in WWII will be uncovered.

V. CURRENT OPERATIONS

A. INTRODUCTION

> Every age had its own kind of war, its own limiting conditions, and its own peculiar preconceptions… It follows that the events of every age must be judged in the light of its own peculiarities (Clausewitz, 1984, p 593).

By the end of WWII, the concept of CAS was highly developed. The role of the FAC, especially his use in ACC, was instrumental in making CAS effective. Technological advances in radar and communications were combined with a unique and flexible command and control organization resulting in a very effective information system. This information system allowed the CAS pilots to quickly locate and accurately attack enemy targets within close proximity of the advancing allied forces.

Today, CAS still remains an important battlefield capability. However, technology has somewhat altered its execution. In the past, WWII CAS pilots engaged their targets at extremely close range in order to increase the accuracy of their weapons. Now, improvements in weapons guidance and sensor capabilities have allowed the shooter to release his weapons at greater and greater distances from the target, effectively decoupling range and accuracy. These technologically enhanced weapons are labeled precision guided munitions or "smart weapons."

The following sections will examine my trip to Nellis AFB to observe Exercise Red Flag 01-02; CAS, FACs, PGMs, and their use in the ongoing operations in Afghanistan. In addition, a brief look at recent cases of friendly fire accidents involving CAS and a discussion of Red Flag 01-02 will be included.

B. EXERCISE RED FLAG 01-02

In January 2002 I had the opportunity to observe exercise Red Flag 01-02. Although this exercise was primarily designed to evaluate the joint services' ability to conduct air supremacy operations, a portion of the exercise was devoted to CAS, FAC utilization, and working with the underlying information system. My role in this exercise was strictly as an observer.

During the first few days of the exercise, I shadowed a USMC Force Reconnaissance unit in the field. Their mission was to observe enemy convoys passing through the area and make "9-Line" (CAS) reports to F-117 aircraft, airborne C^3 aircraft (ABCCC), or the Combined Air Operations Center (CAOC). This exercise was designed to evaluate the feasibility, connectivity and effectiveness of using a USMC SOF unit in conjunction with the F-117. Unfortunately, the exercise was non-productive.

One of the problems that persisted throughout the exercise was an inability to communicate using the designated communications gear. Communications were only achieved (for administrative purposes) via a range control radio (not part of exercise) and commercial cellular telephone. Needless to say, communications training was minimal. The F-117 pilot (commanding officer of the squadron) informed me that he over-flew our position several times and picked us up on his thermal imager (outside air temperature was 10 degrees Fahrenheit at night) but was unable to reach us on any communications frequency (Interview, 24 January 2002).

Another problem encountered was a lack of understanding on the part of the ABCCC and CAOC that the force reconnaissance team was not a highly mobile unit. The force reconnaissance team was inserted via truck and conducted a patrol (several miles on foot) to the designated observation point. At one point in the exercise the ABCCC, with CAOC concurrence, requested the force reconnaissance team relocate to an observation point 12 kilometers away within 15 minutes. This was an unachievable objective. Due to communications problems previously discussed, the force reconnaissance team could not communicate its inability to traverse the 12 kilometers within 15 minutes on foot. That event marked the end of my participation in the field.

I also had the opportunity to inquire about the CAS capability of the F-117. I quickly learned that the F-117 is a very technology dependent aircraft. By that I mean, it is not very flexible in its mission profile. I was informed that the pilot's role is simply to monitor the aircraft's systems. When asked about the Stealth Fighter's ability to perform on-call CAS operations, the pilot stated that it was very difficult to accomplish and very unlikely. Most F-117 missions are pre-planned and have low tolerance for deviation. The onboard computer systems function best according to their pre-programmed mission requirements; deviation form those requirements are not optimal. The pilot did mention that there are efforts underway to make the system more flexible and more multi-mission capable (Interview, 24 January 2002).

My overall impression from Red Flag 01-02 is that the joint services need to take a closer look at the communications shortfalls that exist. Without good communications, operations will cease to be coordinated and effective. This is especially true in joint operations and asymmetrical warfare.

C. PRECISION GUIDED MUNITIONS

The use of PGMs has increased dramatically in the last two decades. Improved intelligence and targeting systems coupled to these weapons has allowed them to become more effective while reducing collateral damage effects. It is estimated that by early February 2002, roughly 10,000 of the 18,000 weapons dropped on Afghanistan were of the precision-guided variety. That equates to 56 percent, compared to the 35 percent of PGMs dropped in Kosovo and nine percent dropped during Desert Storm (Kind, 2002, p 1; Owens, 2000, p 114).

Admiral Bill Owens places PGMs into three distinct categories. The first is the class of PGM that requires the continuous presence of a human being. These weapons are directed, from weapons launch until impact, to their intended targets by a human operator. The tube-launched, optically aimed, wire-guided (TOW) missile and laser-guided bombs are examples of this type of PGM. If, for some reason, the operator takes his eye off the target, the weapon will likely miss (Owens, 2000, p 143).

The second class of PGM does not rely on a human being for its guidance, but instead uses its own sensor, or smarts, to find its target. Some of the sensors that these PGMs utilize are: acoustic, radar, infrared or a combination of these. The torpedo, Sidewinder and Stinger are examples of these weapons. Unlike the previous class of PGMs, these do not require the constant attention of a human being. (Owens, 2000, p 144)

The third type of PGM, and the one that best fits Admiral Owens' system of systems, is the "fire-and-forget" class. These weapons are autonomous and get their guidance information from the global positioning system (GPS) or inertial navigation systems (INS). The current version of the Tomahawk and the Joint Direct Attack Munition (JDAM) both get their main guidance data from GPS. (Owens, 2000, p 144) These weapons do not require information from the target nor are they severely affected by weather. These weapons are considered fire-and-forget because they use GPS and are not tied to the shooter. GPS ties these weapons into the system of systems (assuming GPS will be a vital part of the system of systems).

The majority of the PGMs expended in Operation Allied Force in Kosovo were 1,000-pound laser-guided bombs. These laser-guided bombs home in on a bright spot of reflected laser energy from a laser designator that an aircrew or ground controller holds on the intended target. Laser-guided bombs range in size (500, 1,000, 2,000 and 5,000 pound penetrator) and function. These systems are highly accurate, but poor weather can make them unusable. This variety of PGM was the predominant precision weapon used during Operation Desert Storm. The JDAM, an all-weather, GPS-guided weapon, was introduced during Allied Force and comes in the 1,000 to 2,000 pound variety.

D. CASES OF FRIENDLY FIRE: FRATRICIDE

The development of PGMs and their increased use has played a major role in decreasing the number of friendly fire incidents. However, despite the improved systems, fratricide persists. This unfortunate reality has caused some debate the necessity of CAS. History has proven the utility of CAS, so, the occurrence of fratricide is not likely to end it. This is partly due to the fact that each incident of fratricide is evaluated on a case-by-case basis. Some of these cases will be discussed below.

The first case of fratricide that will be discussed occurred in March 2001. This accident occurred at a bombing range in Kuwait. A Navy F/A-18 dropped three 500-pound general-purpose bombs on the observation post located on the range. Six personnel were killed (including the FAC) and four more were seriously injured. The pilot mistook the observation post as the target. The pilot of the strike aircraft was the commanding officer of his squadron, an experienced aviator.

As previously mentioned, the three bombs were general-purpose bombs, not PGMs. Despite the fact that these were not PGMs, the pilot had communications with the FAC and airborne FAC. The resulting investigation determined that the pilot dropped his ordnance prior to receiving a "cleared hot" report from the FAC. All personnel involved with the exercise were fully qualified, at least on paper. The investigation also blamed lack of CAS training, poor tactics and equipment (Wood, 2001, p 2).

The accident in Kuwait took place after four similar incidents in the previous months. In one of these incidents, an Air Force F-16 pilot misidentified that observation post and fired his rockets at it. In another accident, a Marine F/A-18 pilot dropped one of his 500-pound bombs on the wrong target, nearly killing the ground controllers. These events were documented by the DoD study of close air support at Ft. Irwin. In October 2000, the Joint CAS Study reported that in 22 exercises involving 218 CAS missions, there were major problems in planning, coordination, training and equipment. The report also said that ground control officers (FACs) "are not adequately trained to plan, prepare and execute" CAS.

In a more recent (and more publicized due to surrounding events) accident involving CAS, three servicemen were killed and 20 others were injured when the JDAM they called for exploded in their vicinity. On 5 December 2001, the PGM was released from a B-52 providing CAS to U.S. and Northern Alliance forces in Afghanistan. Details of the exact cause of the accident are not yet known, but it is speculated that the FAC was either too close to the location where the 2,000-pound bomb exploded, he sent incorrect coordinates to the B-52 crew, or the B-52 crewman incorrectly entered the target's coordinates.

Other cases of fratricide or collateral damage (which is considered nearly as bad) in Afghanistan are as follows: 8 October 2001, four UN workers killed in Kabul; 13 October, at least 4 civilians killed when a Navy jet misses its target; 16 October, Red Cross warehouse in Kabul hit by bombs; 22 October, AC-130 hits civilians in Chowkor Kariz village; 8-10 November, 30-70 civilians killed in raids north of Khandahar, etc… There were at least 13 instances of fratricide or unacceptable collateral damage to date in

Afghanistan. How can this happen when such a large percentage of the weapons dropped were smart weapons? Were some of the lessons from the past forgotten or ignored?

There is almost always a specific cause, mechanical or human, which can be identified and corrected, so friendly fire incidents will be reduced incrementally by technological improvements, better procedural controls and better training. Fratricide is preventable but it will continue. This is because, in ADM Stufflebeem's words,

> These are human-made, human-designed systems, and therefore, they're going to have flaws that are going to either be built in or that are going to occur. We have not perfected a technology that is perfect in its execution. However, we have come to expect an extremely high standard with this precision that doesn't really allow for the realities of what happens when it doesn't meet that standard (News Briefing, 5 December 2001).

After the friendly fire accident that killed the three servicemen, the Marine Corps conducted a meeting of its top leadership and subject matter experts to determine if standardized procedures existed for the employment of the JDAM PGM. The meeting resulted in a message (DTG 041530ZJAN02) that implemented temporary safety procedures for the employment of the JDAM. The message pointed out a lack of proficiency of USMC FACs to derive accurate target coordinates and elevation. It directed commanders to evaluate the efficiency of their FACs in these skills as well as their knowledge of JDAM capabilities, limitations and necessity for its use.

Another option for reducing friendly fire casualties can be achieved as a result of the increased accuracy of PGMs. As targeting improves and accuracy increases, the need for 2,000- pound bombs is reduced. When our forces are close to the enemy and call for CAS, a 500-pound PGM can do the job that once required a 2,000-pound bomb. If the 500-pound weapon hits exactly where it is required, then our personnel will not be exposed to the blast effects and shrapnel created if a 2,000- pound weapon were used.

E. IMPLICATIONS OF AFGHANISTAN

Attempting to draw out the implications of the war in Afghanistan can be valuable on some levels, but can be troublesome on others. Since combat operations are ongoing, any conclusions made at this point ought to be taken with some degree of caution. In the area of CAS use and its effects, Afghanistan appears to be fairly cut and dry. At the outset of operations, the U.S. conducted strategic bombing missions that were ineffective. Later on, CAS missions were initiated with FAC. The CAS missions were immediately decisive. The limited, yet highly trained (i.e. special operations forces - SOF), American and British ground forces are operating in an advisory role to the Northern Alliance forces. Although the initial weeks of combat could not be characterized as efficient in terms of CAS, SOF effectively integrated themselves with the Northern Alliance.

After what limited air defenses the Taliban government possessed were defeated, U.S. and coalition force aircraft could operate in a permissive environment. This enabled them to keep collateral damage to a minimum while ensuring accurate targeting. Once this air environment persisted, SOF began to assume the role of FAC. When that occurred, the Taliban and Al Qaida began to lose their hold on power. The lethality of the CAS and FAC coupled with PGM technology had a devastating effect on the Taliban's ability to function. This is similar to the effect that CAS and the FAC had on the Germans in WWII, after the breakout of Normandy.

While the use of SOF units as FAC assets for coalition aircraft was (and still is) quite effective, its value should not be overstated. As previously mentioned, combat operations are not completed. Also, Afghanistan may not be representative of future conflicts. As such, any lessons learned must be cautionary at best. However, it may be possible that the use of relatively few American and British SOFs in the FAC role in addition to the exchange/supply of fairly rudimentary arms to the Northern Alliance may constitute a watershed event in how we conduct future operations in asymmetrical warfare. Only time will tell, but is it possible that we have relied too heavily on high technology as being the only answer to asymmetrical threats?

It seems, at least in Afghanistan, that American and British SOFs had to use local politics, diplomacy, understanding of the culture and extremely flexible coalition building skills to be successful. It also seems, at least on the surface, that technology played a relatively small role in their overall effectiveness. Another factor that may be unique in this situation is the skill of professional soldiering. Deputy Secretary of Defense Wolfowitz, in a recent interview, commented on this. He read two situation reports from an American SOF soldier. The first is dated 25 October 2001 and reads as follows:

> I am advising a man on how best to employ light infantry and horse cavalry in the attack against Taliban T-55 tanks, mortars, artillery, personnel carriers and machine guns – a tactic which I think became outdated with the introduction of the Gatling gun. The Mujahadeen have done this every day we have been on the ground. They have attacked with 10 rounds AK per man, with PK gunners (snipers) having less than 100 rounds… little water and less food. I have observed a PK gunner who walked 10-plus miles to get to the fight, who was proud to show me his artificial right leg from the knee down… We have witnessed the horse cavalry from spur to spur to attack Taliban strong points – the last several kilometers under mortar, artillery, and PK fire. There is little medical care if injured, only a donkey ride to the aid station, which is a dirt hut. I think the Mujahadeen are doing very well with what they have. They have killed over 125 Taliban… while losing only eight. We couldn't do what we are doing without close air support. Everywhere I go the Mujahadeen soldiers and civilians are always telling me they are glad the USA has come. They all speak of their hopes for a better Afghanistan once the Taliban are gone. Better go. The local commander is finishing his phone call with a U.S. Congressman back in the states.

The images that this SITREP conjure up are incredibly dichotomous. Mujahadeen horse-mounted cavalry teamed up with American F/A-18s, F-14s, F-15s and B-52s seems a highly unlikely, if not bizarre order of battle. Notwithstanding, the concept of using B-52s in a close air support role is a new innovation of an old technology (i.e. using a strategic weapon for tactical purposes).

The second situation report that Deputy Secretary of Defense Wolfowitz read is dated, 10 November 2001 and reads as follows:

> Departed position from which I spoke to you last night… We left on horse and linked up with the remainder of the element. I had a meeting with the commander… We then departed from our initial linkup location and rode into Mazar-e-Sharif on begged, borrowed and confiscated transportation. While it looked like a rag-tag procession, the morale into Mazar-e Sharif was a triumphal procession. All locals loudly greeted us and thanked all Americans. Much waving, cheering and clapping, even form the women… USN/USAF did a great job. I am very proud of these men who have performed exceptionally well under very extreme conditions. I have personally witnessed heroism under fire by two U.S. NCOs – one Army, one Air Force – when we came under fire last night, which was less than 50 meters from me. When I ordered them to call close air support, they did so immediately without flinching even though they were under fire. As you know, a U.S. element was nearly overrun four days ago and continued to call close air support and ensured Mujahadeen forces did not

> suffer a defeat. These two examples are typical of the performance of your soldiers and airmen. Truly uncommon valor has been a common virtue amongst these men.

This SITREP says a great deal as well. First, it shows how resourceful and professional our SOF forces are. Secondly, it implies we are somewhat unprepared for this type of contingency: there were not sufficient SOF personnel in place for force protection and, they are not equipped sufficiently so that they are mobile. In addition, communications, data links and targeting systems lack the reliability and range required (*Defense News*, 2002, p 8).

F. CONCLUSION

Operations in Afghanistan are unique and may or may not be good indicators of things to come. Other implications that surfaced, which will be addressed in the next chapter, include questions such as: Did the U.S. force structure and information system in Afghanistan resemble a networked organization? Did this structure lower the intensity of fighting, allowing for "hit and run" air strikes and Northern Alliance clashes with the Taliban, both of which may resemble swarming tactics? How does this paradigm of operations compare to the one employed by the Ninth Air Force in WWII? Other issues that are prominent in this discussion relate to the problem of networked-hiders vs. networked-finders; small groups that are empowered by information technologies; the human mind as the locus of new and old technologies, new and old concepts of operations and the dialectic that results when symmetrical and asymmetrical warfare doctrine clash. Finally, what is the significance of the human element in an information system?

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VI. CONCLUSIONS AND RECOMMENDATIONS

The previous chapters examined CAS and FAC use in WWII, current operations in CAS and FAC as well as operations in Afghanistan. This chapter will examine some of the thoughts of our leadership in light of current operations. The goal of this chapter is to determine the significance that human beings play in information systems based on the WWII case study and the examination of current operations. This chapter will conclude by offering some recommendations and some suggestions for future research on this topic. The next section contains a brief discussion of recent comments from a few senior Navy and DoD leaders.

A. COMMENTS FROM THE LEADERSHIP

"If you're not growing, you're dead" (Clark, 4 February 2002)

The following three subsections contain the insights from three senior Navy and DoD leaders. Their comments focus primarily on transformation and the operations in Afghanistan. I have included them because their comments highlight human interaction with technology and the process of developing new concepts of operations. The discussion on transformation is important because each leader extols the role of the individual sailor, marine, airman and soldier in the process. Each would agree that the role of people in future systems is vital.

1. Admiral Dennis C. Blair, Commander in Chief, U.S. Pacific

During a presentation entitled "Force Transformation in the Pacific" last January, Adm. Blair made some pretty strong comments and indictments about the way our military is going about the current transformation. He acknowledged that we are winning wars with the current systems but that we can do much better. He stated that "we are wasting money, missing opportunities, and, worst of all, not using our greatest resource in the job of transformation – the sailors in the fleet and the soldiers in the field" (Blair, 2002).

I think Adm. Blair is absolutely correct in this estimation of the current transformation. It appears that most of the transformation activity and discussion resides in Washington D.C. and that it is motivated from the top-down. Granted, low and mid-grade military personnel want to see major changes in the services, but the environment for a bottom-up approach to transformation does not yet exist. Currently, transformation is resident only in the briefing slides and boardroom discussions of the flag-ranked officers. If real transformation is to occur, the culture and process of transformation must be inculcated in the lower ranks of the services, possibly tied to a reward system.

Adm. Blair touched on this lack of participation from the lower echelons when he recounted a recent visit he had to an AEGIS destroyer. The Admiral conceded that the improvements made to the AEGIS radar and combat systems were phenomenal. However, his most interesting comments were about an underway replenishment he observed. He noticed that the U.S. Navy still uses a phone and distance line. This line serves as a sound-powered phone communication link between the ships as well as a primitive way of marking the distance between the two ships. It requires six sailors (who end up physically exhausted and wet) on each end of the line in order to provide an inaccurate representation of distance between the two ships.

Adm. Blair commented that, using this system when there are highly accurate laser range finders available is "a symptom of deep systemic shortcomings." I would assume that many ships in the Pacific Fleet might now be using laser range finders (in addition to the phone and distance line of course) after Adm. Blair's comments. A military that encouraged transformational thinking at all levels, somewhat like the Germans in the interwar period, would likely have solved the phone and distance line problem long ago.

Another issue that Adm. Blair talked about was the services' fixation on technology and hardware. There are two dynamics involved with this way of thinking. The first is the dynamic of replacing an aging system with a technically more advanced system. The second dynamic occurs when a new technology is forced into the current way of doing business. Adm. Blair says, "the emphasis is on the hardware – building a new class of platform rather than a new war-fighting capability" (Blair, 2002). These comments suggest that our military frames capability and readiness from a techno-centric paradigm.

Commenting on current and past operations, Adm. Blair cited that there is a lack of development in concepts, command and control and communications. The evolution of CAS in Afghanistan is evidence of this developmental deficiency. He also charged, using events prior to Afghanistan as an example, that some senior leadership claimed that there was no operational requirement for forces to coordinate fires at the tactical level. Recent operations of SOFs, B-52s and Northern Alliance forces have dispelled that belief. He also mentioned that with the new high-tech weapons systems (UAVs, PGMs, etc.) there has not been enough development or thought about how they should be used by our people.

On the issue of using ground forces (i.e. people) or high-tech weapons and information systems, Adm. Blair used this analogy, "Given the choice, would any professional football team rely solely on its receivers and not develop its running game? I want both great receivers and great running backs. I want to have the choice of the pass and the run, depending on the opponent, the field, and the rules" (Blair, 2002).

2. Admiral Vernon Clark, Chief of Naval Operations

On 4 February 2002 the Chief of Naval Operations, Admiral Vernon Clark, had the opportunity to talk to the students and faculty of the Naval Postgraduate School about his views on the future, Afghanistan and the transformation. He expressed agreement with the concept of a capabilities based military vs. the old threat-based military of the past. Adm. Clark reminded the audience that it is the responsibility of those people who wear the uniform and the civilians who work for the government to constantly ask the question, "Whether the capability that is being produced is able to meet the requirements of the President and the Secretary of Defense when we go forward to accomplish missions" (Clark, 4 February 2002)?

Though he did not expressly state it, Adm. Clark suggested that all military members ought to think about the transformation. In an attempt to show how unpredictable this transformation may be (alluding to asymmetrical warfare), Adm. Clark said:

> I don't know how we could have thought through the potential for operations in a place like Afghanistan and thought about the potential for transformation and thought about a bomber, an Air Force bomber or a Navy F-14 or a Navy F/A-18, operating in 24-hour orbits over Afghanistan with a special forces guy on the ground or a special forces guy on a horse and thought that that was going to be called transformation. What it suggests to me is that those people who think transformation is all about high-tech or the introduction of new technology, miss part of the definition of what transformation is all about (Clark, 4 February 2002).

This observation about how the transformation process is proceeding in Afghanistan is important. Adm. Clark stressed that the scenarios that our forces will operate under may be unpredictable. I think that it is the unpredictability that makes having a transformation-minded force important. It is also this unpredictability that will require not only our people to be flexible, but also our systems. Adm. Clark said, "Look, it's like this. The last one wasn't like this one; the next one won't be like this one. This one is like this one and that's what's going on" (Clark, 4 February 2002).

Continuing with this concept of constantly changing circumstances and requirements, Adm. Clark hinted at the need for systems and people that were highly capable and flexible. He said, "We live in a world today that we can't always prepackage and pre-design everything that we might face in the future and what that means is that we have to be able to put together force packages more rapidly than ever before" (Clark, 4 February 2002). This means that we can no longer build weapons and information systems that are so highly specialized that they are not multi-mission capable.

I think that one of the measures of what makes a system multi-mission capable ought to be the level of human input and interaction it allows. For, as mentioned previously in this thesis, until information systems and weapons systems achieve the ability to judge (the act of command), they will always be constrained by their design parameters. The future of transformation should focus on the ability of military people to extract the most utility out of the best technology. In Adm. Clark's words, "Our ability to meet challenges in the future are about our ability to grow minds, our ability to see potential solutions in the future that we can't get by brute forcing the financial [technology] end of this" (Clark, 4 February 2002).

3. Dr. Paul Wolfowitz, Deputy Secretary of Defense

Deputy Secretary of Defense, Dr. Paul Wolfowitz, gave another interesting presentation at the Naval Postgraduate School on 22 February 2002. His presentation focused on transformation, the increased uncertainty in the world and operations in Afghanistan. He said, "In this world that we live in today, it almost seems that surprise and uncertainty are an even more central element to what we do." He went on to say that, "we can't afford to rely too much on single-point predictions of the future. We've got to be prepared for the unexpected" (Wolfowitz, 22 February 2002). Referring to comments made by Secretary of Defense Rumsfeld, Dr. Wolfowitz stated that this transformation is about new approaches to problems, new cultures and mindsets, and new ways of thinking about things. He also said, "We need smart people who can think about old things in new ways that make sense" (Wolfowitz, 22 February 2002).

Dr. Wolfowitz's view of the transformation is that its goal should be that only 10 to 15 percent of the force is transformed. By doing this, he argues, the capability of the entire force can be transformed. He compares this 10 to 15 percent change to that of the German army and its Panzer units in WWII and their Blitzkrieg doctrine. Dr. Wolfowitz maintains that Panzer warfare was the spearhead of the RMA that nearly beat the Allies in WWII. He also talked about the effectiveness of the combination of German dive-bombers with ground troops linked by radio. Quoting General Ehrhart Milch of the German Air Force, Dr. Wolfowitz said, "The real secret is speed – the speed of attack through the speed of communication" (Wolfowitz, 22 February 2002). This reference to the past is valid, but the AAF's use of fighter-bombers, FACs, radar and radios in the ACC concept really brings truth to this quote. Radio and radar were the information system that allowed the air and ground warfighters to take advantage of each other's capabilities.

Dr. Wolfowitz spoke at length about the need for a transformation in thinking, leadership, training, exercises and fighting. He stressed again and again that we must (in addition to improving technology) continue to use old things in new ways. Again, he cited the use of SOF units, B-52s and cavalry in Afghanistan. Dr. Wolfowitz believes that we should use old, technologies with new concepts of operations, while continuously looking for new technologies. Keeping these things in mind, he pointed out six transformational priorities that were outlined in the Quadrennial Defense Review (QDR).

The first priority is the protection of our bases of operation. Dr. Wolfowitz said that we too often underestimate our opponents. Since our enemies may not be able to meet us as equals on the conventional battlefield, they will try to use asymmetrical methods to attack us. Attacking our bases of operations and homeland infrastructure is one way that this can occur. In the future, it would be hubris if the U.S. were not prepared to defend itself against enemies who had long-range PGM capabilities.

Technology cannot isolate U.S. warfighters from the battlefield. Instead, the battlefield will come to them. No force would want or allow its adversary's combatants to have free sanctuary throughout a conflict. Whether deep underground in Colorado or over the skies in the Middle East, Asia or Africa, a determined opponent will seek and find those who would kill them and try to kill them first. It is unpredictable how this may happen, but it will happen. This fact leads to the second priority of transformation.

The second transformational priority is to go after terrorists where they live – denying them sanctuary. This priority is the embodiment of the hiders vs. finders scenario. The issue of hiders vs. finders is becoming more important as our adversaries "packetize" themselves in an effort to evade detection from U.S. sensors. Dr. Wolfowitz expressed the need to exploit our long-range precision strike capabilities to tackle this problem. Commenting on the inter-service argument between air and ground commanders, Wolfowitz said that this priority will work best with air and ground forces working together (Wolfowitz, 22 February 2002). This is evident in the ongoing Afghanistan operations. Using the Gulf war to illustrate this point, Dr. Wolfowitz said:

> …when we were chasing Iraqi Scuds in the western desert of Iraq ten years ago, we had the capability to bomb them from the air but we couldn't find them. We sent brave Special Forces personnel on the ground to find them, but they didn't have the capability to call in timely air strikes. The result was that all we were able to take out during the course of that six weeks of chasing Scuds through the Iraqi desert was one

> dummy." He went on to say, "if you can begin to think about putting ground forces places we never would have thought it possible before, in doing so you will not merely find targets, you will force targets to come out into the open (Wolfowitz, 22 February 2002).

The third priority is to counter hostile states' attempts to keep us out of their geographic areas. One solution to this is increased use of long-range strike capability (i.e. the aircraft carrier, long-range bombers and SOF configured submarines). Reducing the need for forward basing could allow the U.S. to pursue technologies and a concept of operations strategy that would allow swarming. This concept of operations necessitates that forces concentrate on a given target at a given time and disperse after the attack (Arquilla, 2001). Reliance on forward basing may make swarming tactics difficult and predictable.

Leveraging information technology is the fourth transformation priority that Dr. Wolfowitz talked about. The men on horseback calling in CAS from B-52s in Afghanistan were leveraging information technology. That is a prime example of small groups being empowered by information technology (Arquilla, 2001). Dr. Wolfowitz points out that one of the problems facing the U.S. military in this priority is the limitation of bandwidth. This point cannot be stressed enough, "We're going to have to significantly improve the communications backbone of our military forces if we want to take full advantage of the opportunities offered by the information revolution" (Wolfowitz, 22 February 2002).

The fifth category of transformation priority is the conduct of effective information operations. This priority includes the defense and efficient operation of our information systems as well as the attack or disruption of our enemy's information systems. So far, this has not been a challenge for the U.S. in the war on terrorism.

Finally, the sixth priority of transformation is to maintain the unhindered access to space. As space is the ultimate high ground, it will become more important to future operations. More and more of our information systems will rely upon space-based systems and communications satellites. This priority, while not an urgent matter now, it is essential to our future national security.

Deputy Secretary of Defense Wolfowitz reiterated that the key to the current transformation is people and ideas. He said again that it is the people and ideas that this country can generate that is the heart of America's power.

B. CONCLUSIONS

This study examined information theory and looked at what makes up an information system. A couple of things become apparent from this examination. One thing is that information holds different meanings depending on the context in which it is used. Another is that data is not information. Data that is structured, in line and in order can be information; it depends on the user and his interpretations and requirements. Adm. Bill Owens' process of data fusion into meaningful information is a human process. Technology can only speed up that process, not replace it.

An interesting result of the WWII case study was the nature of the Ninth Air Force command and control organizational structure. This structure was very flat in nature when compared with typical military hierarchical structures of that time period. In addition, the Ninth Air Force used liaison officers extensively at every level of the AGF command structure. In essence, the relatively flat organizational arrangement (allowing for significant lateral communications, cooperation and asset rearrangement between units and squadrons), use of liaison officers and FACs, and the unpredictability of the Ninth Air Forces missions made it a highly networked organization. By actively promoting the use of FACs and liaison officers, both as nodes in its network, the Ninth Air Force took advantage of its best resource, human beings. These human beings combined superbly with the developing technologies of radar and radio to be decisive against the German army.

The evolution of the Ninth Air Force's organizational structure occurred over a relatively short period of time (e.g. the U.S. entry into WWII to the breakout of Normandy) and after a great deal of trial and error. The success of this method of organization and resulting operational implementation can be credited to the theater commanders and individual airmen who developed it and made it work. It is a good example of transformation from the bottom up. This case is, perhaps, good grounds for the argument that true transformation and innovation can only occur from the bottom up; it may be the only way to circumvent an organization's innate resistance to change.

The ongoing operations in Afghanistan share some of the same elements as those of the Ninth Air Force in the ETO during WWII. Like the FACs and ACC concept, the SOF units in Afghanistan are able to call for quick and decisive CAS when it is needed. The main difference between the two cases is the technology surrounding the targeting and ordnance delivery capability. GPS and PGMs (deployed from a distance) and satellite communications have replaced the need for the fighter-bomber pilot to have eyes on target for ordnance delivery. Like the FACs in WWII the SOF FACs act as nodes in a broad network of National Alliance forces, aircraft carriers, B-52s, F/A-18s, F-14s, F-15s, F-16s and command centers that span the globe. Even the use of strategic air assets in a tactical environment is not new; although the use of B-52s for CAS has been decidedly better than in WWII (one area where technology improvements have paid dividends in human life).

Afghanistan operations also show us that small groups (i.e. SOF units and the Northern Alliance) can be greatly empowered by information technology. These relatively small groups, using old techniques of land warfare (horse cavalry) combined with new communications technology and PGMs, can defeat a numerically superior force. With the understanding that operations are still ongoing and final judgment must be reserved, it is safe to say that there are valuable lessons to be learned from these events. Hopefully, the lesson of placing capable human beings (warfighters) in a dynamic (asymmetrical) environment with the right tools (technology) can produce astonishing results (victory).

Technology can do a great deal to improve the information systems that warfighters use to carry out their missions. In relatively simple, symmetrical operations, technology may dominate the way warfighters engage the enemy. This was the reality of Cold War doctrine and weapons development. However, as the complexity of the missions increase, as in asymmetrical warfare, the human mind must be the principle element. Information systems and technology will have to support this capability. As quoted by John Arquilla and David Ronfeldt in their 1997 book, *In Athena's Camp:*

Preparing for Conflict in the Information Age, the pulp cinema icon John Rambo said, “the mind is the greatest weapon” (160). The goal of information systems and new technologies should be knowledge enhancement for the warfighter. The two-by-two matrix in figure 10 illustrates this point:

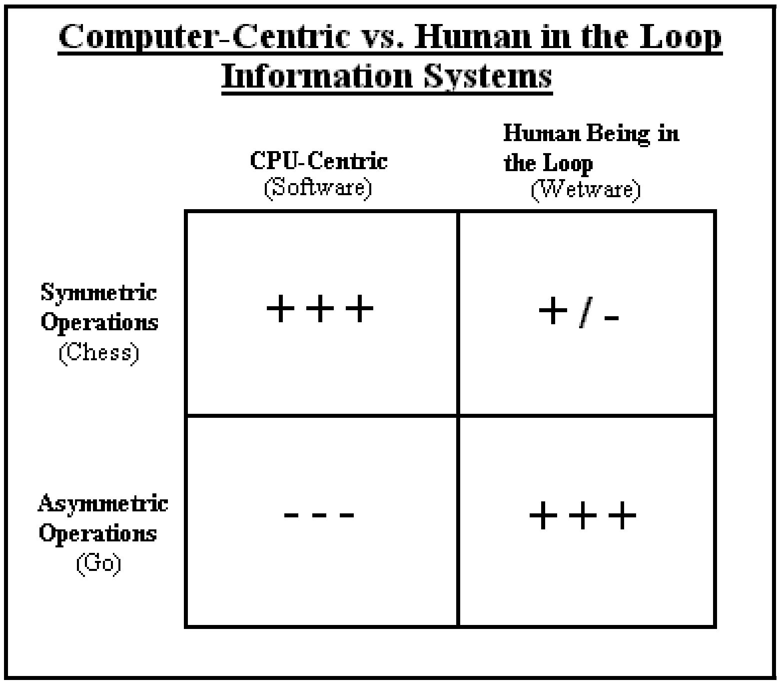

Figure 10. Computer-Centric vs. Human-in-the-Loop Information Systems.

In the preceding two-by-two matrix, I chose to relate symmetrical operations to the game of Chess and asymmetrical operations to the game of Go. The nature of chess is very similar to conventional battles (i.e. before WWII and frequently since, including the Gulf War) where the opposing forces faced each other and battled until a victor remained (Arquilla and Ronfeldt, 1997, p 161). In these scenarios, a computer can do an outstanding job calculating moves to counter its opponent. Therefore, a computer is often much better at this “game of calculation” than the human being (Arquilla, 2002). That is the reason for the three plusses in quadrant one.

Clausewitz’s “fog of war” and human cognitive limitations are responsible for clouding man’s judgment resulting in mistakes and miscalculations. Occasionally, a military genius may come along and manage to “see” more than his opponent. The presence of fog in war and the occasional military genius makes determining the outcome for quadrant two troublesome; therefore, a plus and minus in quadrant two is logical. Again, quadrant one and two represent symmetrical operations.

The game of Go is very different from Chess. In Go, the game starts with no pieces on the board. The game proceeds on a very asymmetrical course, it is not linear like Chess. Go requires one opponent to encircle the other and its focus is on the edges and corners of the board where it is easier to isolate and thus control territory. "Thus Go, in contrast to Chess, is more about distributing one's pieces than about massing them. It is more about proactive insertion and presence than about maneuver" (Arquilla and Ronfeldt, 1997, p 163).

Go is more akin to a network approach to warfare. Because it is not linear, computers have a difficult time doing the calculations necessary in Go. This is the same for asymmetrical operations. They can also be conducted in a distributed, network-like fashion. For these reasons, quadrant three, asymmetric operations with computers, gets three minus signs. On the contrary, the human mind is very adept at asymmetrical thinking. It is linked to creativity and human cognition. Human beings can often operate far better in an unpredictable environment where computers are at a disadvantage (Arquilla, 2002). This is why quadrant four rates three plusses.

Hopefully, the two-by-two matrix in figure 10 illustrates what this thesis has set out to accomplish (i.e. to determine the significance of the human element in an information system). Human beings are indeed essential elements in information systems. An information system without human interaction cannot logically be called an information system since it does not inform anyone. Information technology has done a great deal to improve information systems and improve warfighting capabilities. What is important is that commanders and information systems designers do not fixate on the technology but the people who use it.

The WWII case study and examination of current operations show that technology (the information system) played a secondary, yet essential, role in operations. The human influence, through tactics, doctrine development, organizational change and trial and error, was the decisive and key element in each case. Other issues that presented themselves in this study include: communications difficulties continue to hinder efficient operations; inter-service rivalry and non-compatibility (technological as well as cultural) are still factors that limit military effectiveness; innovation may be more effective if it is fostered from the bottom-up vs. the top-down; innovative thinking ought to be sponsored at all levels in the military; organizational change is slow but may evolve out of necessity, as it should; and finally, technology should follow required functions (tactics and strategy should not be dictated by technology).

C. RECOMMENDATIONS FOR FUTURE STUDY

This study focused primarily on the WWII case study of CAS and FAC. It took the analysis of that case study and applied/compared it to current operations. In this instance, the significance of the human element in information systems was shown to be quite great. In fact, the presence of the human being was decisive in operational effectiveness. It is recommended that this study be expanded to include other conflicts where CAS and FACs were used or not used. It would be very beneficial to determine if the conclusions reached in this study hold true in other scenarios.

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